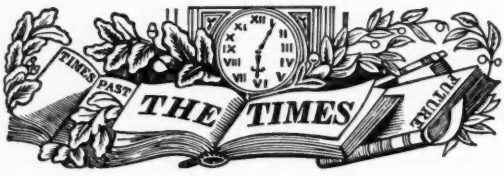
THE POPULAR JOURNAL OF KNOWLEDGE

DISCOVERY

CAMBRIDGE: FEBRUARY 1939

- WILD ANIMALS AT CLOSE QUARTERS
- PLASTICS FOR HOUSES AND CLOTHES
- MR. TOMPKINS IN WONDERLAND: 3rd Dream
- FOODS FOR ENERGY AND PROTECTION
- COLOUR IN PAINTING



READING WITHOUT TEARS

WHEN Mr. Kipps's solicitor saw the prospectus of the Associated Booksellers' Trading Union, Limited, he at once suspected fraud. It was far too well printed, Mr. Bean thought, for a reputable undertaking.

It is true that the matter best worth reading is not always the easiest to read. But in the important case of the daily newspaper that is happily not so. *The Times* yields to no newspaper in the world for care in the quality of its printing or regard for the eyesight of its readers.

Before the days of mechanical typesetting it was the practice of *The Times* to have completely new type from the typefounders every day, so that no letter was ever used more than once. Nowadays typesetting machinery automatically casts every letter fresh for every use.

In 1932 *The Times* undertook the immense and costly labour of designing an entirely new typeface for its own daily use. The style of letter adopted was the result of long experiment, in the course of which the results of scientific and medical inquiries into the causes and relief of eyestrain were carefully examined.

The Times has recently completed, at a cost of £400,000, the erection of completely new printing plant in which the latest and best proved devices for perfect rotary printing have been installed.

The paper on which *The Times* is printed is of exceptional quality —white, opaque, and super-calendered.

Glance at the "lay-out" of *The Times* page by page. That, too, has been the subject of long and careful study. Simple, clean, and dignified, free of eccentricities and sharp contrasts that disturb the eye. It has been planned, too, in such a way that you can find what you are seeking without bother or fuss. If your daily reading of *The Times* is not a pleasure to you, then many honest craftsmen must admit failure in a task to which they have devoted the sincere efforts of their lives.

DISCOVERY

New Series, Vol. II, No. 11 FEBRUARY 1939 **1s. net**

Published by the CAMBRIDGE UNIVERSITY PRESS, Bentley House, 200 Euston Road, N.W. 1 (Tel.: Euston 5451–3)

Editor: C. P. SNOW, University Press, Cambridge (Tel.: 4226)

Advertisement Offices: 61 Chandos Street, W.C. 2 (Tel.: Temple Bar 6897)

Annual Subscription, 12s. 6d. net post free

Sole agents in the U.S.A., The Macmillan Company. Annual Subscription $4.00

Sole Agents for South Africa: Central News Agency Limited (London agents: Gordon and Gotch Limited)

Copyright reserved throughout the countries signatory to the Berne Convention and the U.S.A.

For the Protection of Science and Learning

A MESSAGE FROM SIR WILLIAM BEVERIDGE

PERHAPS there is no finer testimony to the work undertaken by the Society for the Protection of Science and Learning, whose report for 1938 has recently been issued, than the extent to which it has received the active support during the whole of its five years' existence of the University staffs in Great Britain. Not only have individuals and committees in the majority of academic centres lent ready assistance to their exiled colleagues from abroad, in the way of advice and vigilance for new openings for them, but also they have contributed financially over £10,000 towards the funds of the organization which seeks to aid academic refugees. There is practically no college or university which is not offering a home to at least one refugee, and, since recent occurrences abroad, there has been a renewal of activity and interest. Balliol College (by no means one of the richer foundations) has voted £1000 to be spent on the assistance of exiled scholars; Christ Church has put aside £180 a year for three years; this in addition to what these two colleges were already doing for refugees in their midst. Glasgow University has just made an appeal to its staff for a special levy in aid of refugee scholars, while at Edinburgh, Professor Dover Wilson has offered to give a special series of lectures on Shakespeare on behalf of funds for academic assistance.

The Society itself has arranged a week of meetings to take place shortly in the great majority of British academic centres, to spread information and sympathy concerning the plight and prospects of academic refugees. During this week meetings will be held in London, Oxford, Cambridge, Manchester, Birmingham, Bristol, Exeter, Nottingham, Leeds, Liverpool, Hull, Bangor, Glasgow, Edinburgh, St Andrews and Aberdeen. Among those who have agreed to take part in these meetings are included: the Home Secretary, the Archbishop of York, Viscount Samuel, the Marquess of Reading, Sir William Bragg, Sir H. H. Dale, Sir Richard Gregory, Bart., Sir John Hope Simpson, Sir Norman Angell, Sir Alan Mawer, Sir Bernard Pares, the Hon. Harold Nicolson, Mr Philip Guedalla, Mr Walter Adams, Professor Gilbert Murray, Professor Winifred Cullis, Professor John Macmurray, Professor P. M. S. Blackett, Professor Lancelot Hogben, Professor F. A. E. Crew, Miss Rebecca West and the Hon. V. Sackville-West. In the great majority of cases the Vice-Chancellor or the Principal of the college concerned will be taking the Chair.

To mark its whole-hearted approval of this academic testimony to the importance of the work being done by the Society for the Protection of Science and Learning, the Royal Society, in collaboration with the British Academy, is giving a special reception to academic exiles and those who have been working in their interest, on 7 February 1939; and on 10 February the evening discourse at the Royal Institution is to be given by Professor Max Born, one of the most distinguished of the refugee scientists.

Instead of making an appeal ourselves to our readers in a cause for which we know all will have sympathy, we are glad to print the following letter from Sir William Beveridge, the Vice-President of the Society:

"I should be grateful if you would allow me through your columns to draw to the attention of your readers the special contribution which the Society for the Protection of Science and Learning is making, and has been making over the past five years, to the refugee problem, which the whole of the civilized world is to-day facing with such remarkable spontaneity and generosity.

"This Society (of which His Grace the Archbishop of York is President and Sir Frederic Kenyon Chairman) exists to help scholars and scientists displaced from their own Universities and professions to be re-absorbed into academic life elsewhere, so that their intellectual gifts and training may not be wasted and so that each individual scientist, scholar and doctor may still be able to make the contribution to knowledge which in many cases he and he alone is capable of making. So far we have succeeded in placing over 500 permanently and nearly 350 temporarily and amongst those whom we have been privileged to help are men and women whose intellectual gifts and genius form part of the cultural wealth of the world.

"The Society is holding a number of meetings early in February in the academic centres throughout the country to enable all those engaged in teaching, learning and research to give corporate and tangible expression to their sympathy. I hope

these meetings will have the most generous possible support, as the latest developments in Germany, the crisis in Czechoslovakia and the new legislation in Italy have trebled our waiting lists and made each individual problem more pressing and acute. As Vice-President of the Society I should be grateful if you would publish this letter so that this part of the work undertaken to help these distinguished refugees and exiles of learning may be widely known."

SYNTHETIC PLASTICS

Their Influence on the Future

By H. COURTNEY BRYSON

II.

(In his second article on the increasing use of plastics, Mr H. COURTNEY BRYSON gives us a prophetic glimpse of the world of the future, where men, clothed in simple Greek-like costumes, live in moulded houses, translucent and colourful, which, by their enormous height, allow the inhabitants to change climate by a mere change in altitude.)

CELLULOSE (in the form of cotton) is the chief source of clothing, with wool second and artificial silk next. Wool was man's first manufactured covering, and continued to be his principal covering until cotton took its place a century ago. Although it now looks as if cotton is to be superseded by artificial silk, there is no doubt that it will be increasingly cultivated. It is the purest natural form of cellulose we have. Nature can build it up far more cheaply than the chemist. We can only help, just in the same way as with rubber, by inducing increased yields per acre and extending the present limits of cultivation.

Up to the present time all clothing has been made from fabric, and even when the fibre has been synthetic it has nevertheless only aped the natural product to a greater or less extent. Soon new materials will appear with their own inherent characteristics, more beautiful and more useful than anything we now know, warm, soft, and stronger than linen.

Woven or matted fibres have always been selected because the result is flexible and the trapped air cells make good heat insulators. Partly on account of the large surface exposed, the tendency is for fabrics to resist penetration by water and yet permit a certain freedom in the passage of gases. There should be no insuperable difficulty in making a material in the form of fine and exceedingly flexible sheets having a high heat-insulating value, which would be in the nature of a semi-permeable membrane in that it would be very water resisting and yet, by osmosis,

allow the escape of body vapours. Such a material would probably be cheap to produce, and would further extend the range of colour effects and textures. The research, which will precede the production of this material, may at the same time provide us with its opposite, viz. the ideal material for airship envelope construction, capable of resisting the diffusion of hydrogen through it at any pressure.

With the advent of these innovations, man will have the sense to discard his present hideous, cumbersome, insanitary and uncomfortable garments and revert to some simple and artistic form of covering. Anyone would appreciate the sense of freedom which the expressive draping of the ancient Greek costumes afforded: man will never again go naked as has often been predicted, for the social, ceremonial and aesthetic claims of clothing are much too strong. The awkward complexity of modern clothing is almost sufficient proof of this.

The Dress of the Future

The dress of the future will probably consist of an undergarment, varying in warmth with the season, of a synthetic fabric possessing a pleasing semi-matt finish. Covering this will be an outer Greek-like costume, of a glossy transparent sheet, tinted in another but harmonizing shade, through which the undergarment will show in colours and shades varying with the movements of the wearer.

The enlightened being thus clothed will not tolerate in his home the appalling assortment of dust-collecting articles and ornaments harboured by the present-day villa. Simplicity will be the keynote of the house of the future, but it will be the simplicity of expensive and artistic concealment.

The standard house has been predicted many times. It will come. This does not necessarily imply a rigid adherence to pattern. Within the limits of the units, it should be possible to produce a pleasing divergence of form. It is to be expected that a large part of such houses will be produced from moulded or cast units, despatched in plain packing cases, ready for erection on the site. The farther we proceed along our present lines of development the more difficult will this procedure be, as houses progressively become less and less mere piles of hollow boxes, with holes to let out the smoke, and more and more structures to hold together complex assortments of channels and conduits for water and gas and electricity, and waste products, complicated by junction boxes and meters and telephones all designed on the best labour-saving principles to be inconspicuous and hygienic. A list of spare parts will be provided so that, in the event of breakage, duplicates can be ordered by code word from the factory or accredited agents only.

The House of the Future

In days gone by 90 % of the purchase price of a house was represented by bricks and mortar. To-day 50 % of the cost of a house is represented by the fittings, and this is likely to increase in the future. The actual structural materials will be decided largely by cost. It is unlikely that we shall ever see a return of the all-metal house.

Concrete and organic glass, or organic glass and synthetic wood, are likely to be widely used, as the plasticity of these materials will permit of pleasing diversity of form.

It must be borne in mind that whilst form has never been dependent on material, yet it has always been influenced by it. As the properties of these new materials begin to be understood, new conventions will arise. The "suburban residence" will probably be an apparently simple affair of one or two storeys with no internal walls. It will be servantless. There will be a complete absence of corners, and what little furniture is retained will be built in. The lighting will be elaborate, variously coloured and concealed. The whole of the decorative effects will be obtained by colour and texture and, to a lesser extent, by form.

The cupboards and all the multitudinous electrical devices will be in the thickness of the outer walls, which will be impervious to heat and cold and sound. The walls may or may not be translucent. The roof or ceiling will certainly be transparent. It will be divided up in such a way that by pulling down shutters any specific part of the house may be shut off from any other to form temporary rooms of the required size and shape. These shutters of plastic material will either be coloured or irradiated with coloured light, for we may assume that the art of chromatic therapeutics, i.e. the health value attaching to specific colours, will be well established.

The whole of the internal fittings will be either of rustless metal, or moulded from a plastic. Ceramics will be out of date by this time. All such vessels and containers as will be needed will be unbreakable and transparent, for our aesthetic sense is agreeably stimulated by the play of light and colour in beautiful, transparent and translucent objects.

Moulding is not of necessity the best method of producing articles from plastic materials. One great drawback is that the cost increases out of proportion to the size of the article. A new material is required which will possess the property of plaster of Paris, of making an accurate reproduction and taking colour readily, and yet be free from its disadvantages of brittleness and porousness.

The Time Switch

These houses will be equipped with a further detail which will produce far-reaching consequences. I refer to the long overdue development of the time switch for the automatic performance of all intermittent periodic duties. Up to now the cheaper ones have been unreliable and the reliable ones expensive. It should be possible to manufacture time switches, in small moulded cases, on the lines of the synchronous motor clock, which are both accurate and inexpensive.

It could be used as a door control permitting entry only at certain specified times. With such switches the individual of the near future will be gently awakened to a nicely warmed room wherein a cup of hot tea is waiting while the bath water is

automatically turned on. In the evening a meal will be automatically cooked pending the return of the householder and served up on the table at the correct hour by an automatic sliding tray and small lift, which will also be used for the automatic return of the table with the empty dishes to the kitchen. These switches will all be capable of remote control.

As we look still farther forward into the future, our yearning towards idealism causes us to postulate a genus which will succeed *homo sapiens*, and will look back in astonishment at the creatures of this age drenched in a monstrous madness which desires peace and prepares for war, which suffers from over-production of most commodities and allows part of its population to be in want of necessities.

Control of Weather

To this happy race of *homo intelligens*, slums will be unknown. Huge buildings two, three and four miles high will allow individuals the choice of living in any climate by mere change of altitude. By this time meteorology, having become a proper science by achieving accurate prediction of the weather, will have taken the next step and be far on the road towards weather control. Fogs will be dispersed by electrical discharges between neighbouring buildings spaced at a distance of many miles; clouds and rain will be influenced as desired by ionization of the upper air; and the barren places of the earth will be rendered fertile.

Each continent will be covered with these sparsely scattered estates united by broad straight highways along which in ceaseless streams all the heavier merchandise in vehicles controlled by distant agencies will flow. Overhead and along the centre of these broad avenues, which will be used for all short-distance transport, a thin power cable will be stretched and the vehicles will tap their energy from this by means of a thin jet of liquid (or possibly highly ionized gas) which will fall back on the roof and which will be kept directed on to the cable by a device in the nozzle. In this manner the passing and manœuvring of various vehicles will be accomplished without hindrance.

The sight of living creatures on these roads will be a rarity, for all passenger services as well as the lighter transport will be entirely aerial: indeed, there will probably exist beings who, in the whole of their life, will never come within half a mile of the surface of the earth. Some of the more atavistic will have small chalets in the far places of the earth, which of set intention will have been left wild, to which they will go in their aerial boats or in the giant air liners plying at great heights and incredible speeds between continent and continent. The wings and body of these planes will be constructed from a plastic material calculated to resist both the heat due to friction on descending and the ultra-violet rays at extreme heights. The formation of progress-retarding frost on the surface will be prevented, possibly by internal heating, or more likely by studying the nature of the surface in order to inhibit the initial deposition of ice.

All the buildings will be constructed so that the walls or roof can be removed completely or partly for sun bathing, even though the practice of artificial irradiation will be widespread.

Each building will be zoned on all sides in a succession of receding stages, gathering at one end into a huge tower-like summit, which will be used as a mooring mast for lighter-than-air craft. Aesthetic needs will be satisfied largely by form, texture and colour, for the use of extraneous adornments will have died out altogether. Form will be simple and severe and controllable to an extent which has never been possible in the past owing to the limitations of the structural materials. Huge blocks of plastic silica or silicates moulded or cast *in situ* will permit the construction of either the most rugged outlines or the most fantastic and delicate shapes by reason of the enormous strength of the basic material.

Texture and colour will be interlinked so that the scintillating brightness of metal will act as a foil to the matt surface of concrete and the delicate satin shades of faience.

Living in the High Buildings

It is improbable that the higher storeys of these buildings will be supplied with oxygen, except possibly those in the tower that top the four-mile mark, for we have recently learned that man's adaptability to altitude is very much greater than was originally thought. It is improbable that snow will be allowed to accumulate on the upper surface which will naturally be required for an air park and used as a flower garden. Artificial heating will stop this and those who desire alpine delights will find them on the big tower or within half an hour's flight from their homes.

The rooms will be almost bare, for simplicity and austerity will be dominant. Book-cases harbouring dusty and bulky volumes will have been dead many centuries. Knowledge will be recorded on minute rolls of plastic material reproducible either visually or audibly by a small and convenient mechanism.

I have tried to show that the achievement of this world state, wherein plastics would be used for clothing as well as for carriages and ceramics, and for structural materials of all kinds, is solely dependent upon one factor—human nature. It is easy, Alnaschar-like, to dream of the splendid future that can be built up by means of our little tray of glassware, and then by a kick of the foot to send both dream and reality flying. Is not the shibboleth of the immutability of human nature both fallacious and pernicious? Even a cursory examination demonstrates the existence of enormous temporal and geographical variations. At the present moment the predominant ambition of the societies of Western Europe and America is wealth and the power that accompanies it. This passion which seems to us so worthy of esteem, so inevitable and so natural, to an ancient Athenian or to a true Buddhist would appear, if not repugnant, at any rate incomprehensible. Imagine for example the consequences which would follow were a few generations of our younger men

to direct the same amount of energy and enthusiasm towards poetry and religion as to-day they display towards science and technical matters. The dream pictures I am giving would, to such an individual, be nightmare pictures. He would substitute prayers for petrol and would replace reason with reverie:

"What am I?
An infant crying in the night;
An infant crying for the light;
And with no language but a cry."

NOTES ON CLOUDS

Observed from Glenn Cannel, Isle of Mull

SHORTLY after 3 p.m. on 15 June 1938, looking from a little south of the shepherd's house in Glen Cannel (marked Gortenbuie on the 1 in. Ordnance Survey Map), Isle of Mull, I noticed an unusual cloud formation apparently over Corra-Bheinn, 2309 ft., which lay about 2 miles to the south-west.

The day was fine, and small clouds at roughly 3000 ft. were being blown over the hills by a strong north-west wind.

An arc of brilliantly sunlit cloud, of roughly inverted saucer shape, would form slightly to the left or south-east of Corra-Bheinn, and apparently slightly above its summit. It would remain, in its first stages, apparently stationary, being obscured from time to time by the normal clouds passing across. The upper edge was symmetrical and very sharply defined against the sky.

The tips of the arc would grow outwards quite rapidly, and as maximum diameter was reached, a smaller but less well-defined arc would sometimes appear above the first—corresponding to the seat of a saucer. A brilliant but softly defined mist would then form downwards under the arcs, sometimes of inverted conical shape, at other times irregular, or with hollow whorls eating into it.

After about a minute from the start, the whole formation would begin to lose brilliancy and drift slowly to the south-east. As it finally faded the radius of the arc would become smaller, and immediately it disappeared a new arc would form in the original position.

Some six of these cycles were observed without interruption. The ordinary clouds then grew larger and darker, the wind seemed to veer west, and the formations ceased.

Corra-Bheinn is mentioned only to give the rough bearing and apparent altitude of the clouds, as the intensely sharp definition of their tops led me to suppose that they were a considerable distance away.

Assuming that the clouds formed over

1.

2.

3.

4.

The photographs are not of the same cloud cycle, but of four different cycles, as the passing normal clouds made continuous exposures difficult. They were taken, however, as marked 1, 2, 3 *and* 4, *at progressive stages*

or near land—the farthest part of Mull is only about 10 miles away, and the next approach to land is Colonsay, about 30 miles. If the clouds were 30–40 miles away, they would be about 40,000–50,000 ft. high. Is this feasible? F. PIGOT

We submitted Mr Pigot's photographs and letter to Mr Robin Hill at Cambridge who writes as follows:

Lenticular Clouds

THE north-west air current is being thrown into a state of turbulence by the land masses. Such a region of turbulence may remain localized and give rise to the remarkable cloud shown in the series of pictures. The actual formation of visible cloud may be due to the local lifting of a layer of nearly saturated air, so that condensation takes place. While the cloud itself appears almost stationary, the actual cloud particles are moving with the wind; condensation takes place on the windward, evaporation on the leeward side. This is a characteristic of lenticular clouds in general. Sometimes it is possible to observe the formation of a small cloudlet, and after watching its passage through the main cloud see its disappearance at the farther edge. The most striking feature of lenticular clouds is the sharply defined and smooth convex outline. This is well expressed in the name "Contessa del Vento" given to a cloud seen at times near Etna; the mountain mass causes a localized turbulence in the air current and the almost stationary cloud sometimes formed suggests the feminine bust (see Napier Shaw, *Manual of Meteorology*, vol. I (1926), Plate IV, fig. 46).

Clouds of lenticular type may appear at almost any cloud level, but they are most frequent between 7000 and 12,000 ft.* Sometimes they may appear above growing cumulus clouds in the form of a lens-shaped "cloud cap"; later the head of the cumulus may grow through the cap which then forms a "scarf cloud". A lenticular cloud at a much lower level may often be seen over the island of Scarba during a damp south-west wind; when viewed from the mainland the island seems to have a mushroom-shaped cap slightly above the summit. The peculiar texture seen in lenticular clouds, and their appearing not to move with the wind, makes visual estimation of their height difficult. In these pictures it is not possible to determine the actual distance of the cloud from the observer. The turbulence causing the formation of cloud may be some way from the relevant land mass. The appearance of the cloud in the photographs suggests a height not greater than 9000 ft., and the actual height may be considerably lower.

ROBIN HILL

* *A reference to lenticular clouds and their height is to be found in* The Sailplane, *November* 1937, *p. 256. Three flights were made in sailplanes at the Long Mynd, the greatest height reached was 7100 ft. Although no clouds of lenticular type were present during these flights, they were observed in the same place and at about the same height at other times during the same day. The highest lenticular cloud made use of by sailplanes was in Germany, when heights of 18,000–19,000 ft. were reached at Grouneau.*

Mr Tompkins in Wonderland

By Professor G. GAMOW

Dream III: City Speed Limit*

MR TOMPKINS liked his dreams and was anxiously awaiting next week to get some more material for his night adventures. But he was very disappointed to find that the lecture on quantum theory was the last, and that there would be no more lectures that year. His disappointment was smoothed down a little, however, when he managed to get a manuscript of the first lecture, which he had missed.

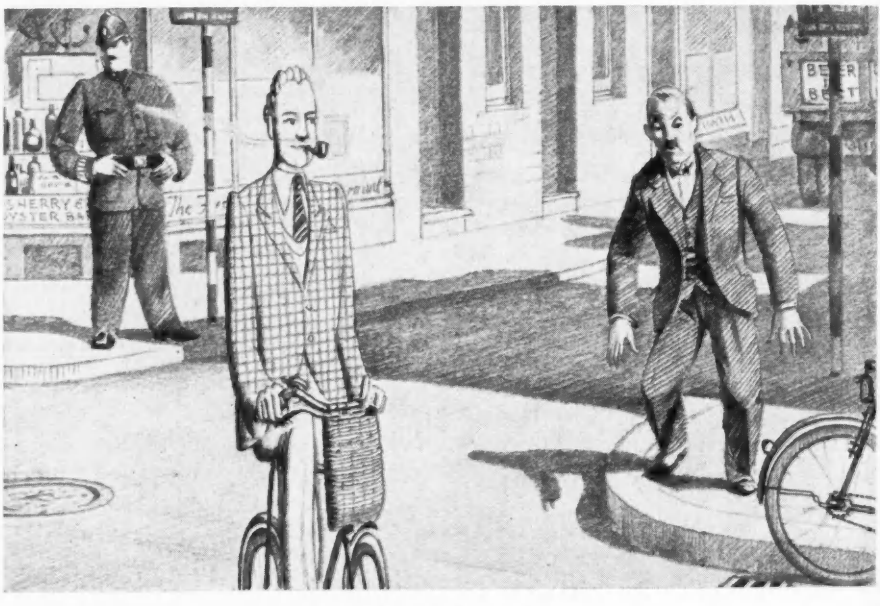
This morning the big hall of the bank was almost empty and Mr Tompkins, hidden behind his little window, opened the thick manuscript and tried to get through the impenetrable hedge of formulae and complicated geometrical figures by which the professor attempted to explain the theory of relativity to his students. But he only got as far as understanding that the whole point of this lecture was that there is a maximum velocity, the velocity of light, which cannot be surpassed by any moving material body, and that this fact leads to very strange and unusual consequences. It was stated, however, that as the velocity of light is 186,000 miles per second, the relativity effects could hardly be observed for events of ordinary life. But the nature of these unusual effects was really much more difficult to understand, and it seemed to Mr Tompkins that all this was contradictory to common sense. He was trying to imagine the contraction of measuring rods and the odd behaviour of clocks—effects which should be expected if they move with a velocity close to that of light—when his head slowly dropped on the typewritten pages.

* * * *

When he opened his eyes again he found himself standing at a street corner in a beautiful old city. He suspected that he was dreaming now, but to his surprise there was nothing unusual happening around him; even a policeman standing on the opposite corner looked as policemen usually do. The hands of the big clock on the tower down the street were pointing almost to noon and the streets were nearly empty. A single cyclist was coming slowly down the street and, as he approached, Mr Tompkins's eyes opened wide with astonishment. For the bicycle and the young man on it were unbelievably flattened in the direction of the motion, as if seen through a cylindrical lens. The clock on the tower struck twelve,

* In this story the velocity of light is about 10 miles per hour, the other world constants are as usual.

and the cyclist, evidently in a hurry, stepped harder on the pedals. Mr Tompkins did not notice that he gained much in speed, but, as the result of his effort, he flattened still more and went down the street looking exactly like a picture cut out of cardboard. Then Mr Tompkins felt very proud because he could understand what was happening to the cyclist—it was simply the contraction of moving bodies,

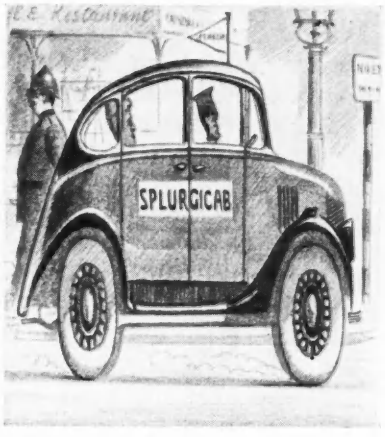


"*Unbelievably flattened*"

about which he had just read. "Evidently nature's speed limit is lower here," he concluded, "that is why the bobby on the corner looks so lazy, he does not care for speeders." In fact, a taxi moving along the street at the moment and making all the noise in the world could not do much better than the cyclist, and was just crawling along. Mr Tompkins decided to overtake the cyclist, who looked a good sort of fellow, and ask him all about it. Making sure that the policeman was looking the other way, he borrowed somebody's bicycle standing near the kerb and sped down the street. He expected that he would be immediately flattened, and was very happy about it as his increasing figure had lately caused him some anxiety. To his great surprise, however, nothing happened to him or to his cycle. On the other hand, the picture around him completely changed. The streets grew shorter, the windows of the shops began to look like narrow slits, and the policeman on the corner became the most meagre man he had ever seen.

"By Jove!" exclaimed Mr Tompkins excitedly, "I see the trick now. This is where the word *relativity* comes in. Everything that moves relative to me gets

shorter for me, whoever works the pedals!" He was a good cyclist and was doing his best to overtake the young man. But he found that it was not at all easy to get up speed on this bicycle—the faster he went the more resistance he met when he tried to go faster still. And it was not the resistance of the air at all—in fact at such low speed he hardly felt any wind—but it seemed to him that the bicycle was getting heavier and heavier as he tried to move faster. "The mass of any body is increasing with its velocity and becomes infinite at the limiting velocity of light"—he remembered this sentence of the professor's, and at once the impossibility of getting over this limit became clear to him. He overtook the cyclist at the second turning and, when they had been riding side by side for a moment, was surprised to see that he was quite a normal, sporting-looking young man. "Oh, that must be because we do not move relative to each other", he concluded; and he addressed the young man.



"Excuse me, sir!" he said, "Don't you find it inconvenient to live in a city with such a slow speed limit?"

"Speed limit?" returned the other in surprise, "we don't have any speed limit here. I can get anywhere as fast as I wish, or at least I could if I had a motor-cycle instead of this nothing-to-be-done-with old bike!"

"But you were moving very slowly when you passed me a moment ago", said Mr Tompkins. "I noticed you particularly."

"Oh you did, did you?" said the young man, evidently offended. "I suppose you haven't noticed that since you first addressed me we have passed five blocks. Isn't that fast enough for you?"

"But the streets became so short," argued Mr Tompkins.

"What difference does it make anyway, whether we move faster or whether the street becomes shorter? I have to go ten blocks to get to the post office, and if I step harder on the pedals the blocks become shorter and I get there quicker. In fact, here we are", said the young man getting off his bike.

Mr Tompkins looked at the post office clock, which showed half-past twelve. "Well!" he remarked triumphantly, "it took you half an hour to go this ten blocks, anyhow—when I saw you first it was exactly noon!"

"And did you *notice* this half hour?" asked his companion. Mr Tompkins had to agree that it had really seemed to him only a few minutes. Moreover, looking at his wrist watch he saw that it was showing only five minutes past twelve. "Oh!" he said, "is the post office clock fast?" "Of course it is, or your watch is

too slow, just because you have been going too fast. What's the matter with you, anyway? Did you fall down from the moon?" and the young man went into the post office.

After this conversation, Mr Tompkins realized how unfortunate it was that his old friend the professor was not at hand to explain all these strange events to him. The young man was evidently a native, and had been accustomed to this state of things even before he had learned to walk. So Mr Tompkins was forced to explore this strange world by himself. He put his watch right by the post office clock and, to make sure that it went all right, waited for ten minutes. His watch did not lose. Continuing his journey down the street he finally saw the railway station and decided to check his watch again. To his surprise it was again quite a bit slow. "Well, this must be some relativity effect, too", concluded Mr Tompkins; and decided to ask about it from somebody more intelligent than the young cyclist.

The opportunity came very soon. A gentleman obviously in his forties got out of the train and began to move towards the exit. He was met by a very old lady, who, to Mr Tompkins's great surprise, addressed him as "dear Grandfather". This was too much for Mr Tompkins. Under the excuse of helping with the luggage, he started a conversation.

"Excuse me, if I am intruding into your family affairs," said he, "but are you really the grandfather of this nice old lady? You see, I am a stranger here, and I never...." "Oh, I see", said the gentleman, smiling with his moustache. "I suppose you are taking me for the Wandering Jew or something. But the thing is really quite simple. My business requires me to travel quite a lot, and, as I spend most of my life in the train, I naturally grow old much more slowly than my relatives living in the city. I am so glad that I came back in time to see my dear little granddaughter still alive! But excuse me, please, I have to attend to her in the taxi", and he hurried away leaving Mr Tompkins alone again with his problems. A couple of sandwiches from the station buffet somewhat strengthened his mental ability, and he even went so far as to claim that he had found the contradiction in the famous principle of relativity.

"Yes, of course," thought he, sipping his coffee, "if all were relative, the traveller would appear to his relatives as a very old man, and they would appear very old to him, although both sides might in fact be fairly young. But what I am saying now is definitely nonsense: One could not have relative whiskers!" So he decided to make a last attempt to find out how things really are, and turned to a solitary man in railway uniform sitting in the buffet.

"Will you be so kind, sir," he began, "will you be good enough to tell me who is responsible for the fact that the passengers in the train grow old so much more slowly than the people staying at one place?"

"I am responsible for it", said the man, very simply.

"Oh!" exclaimed Mr Tompkins. "So you have solved the problem of the

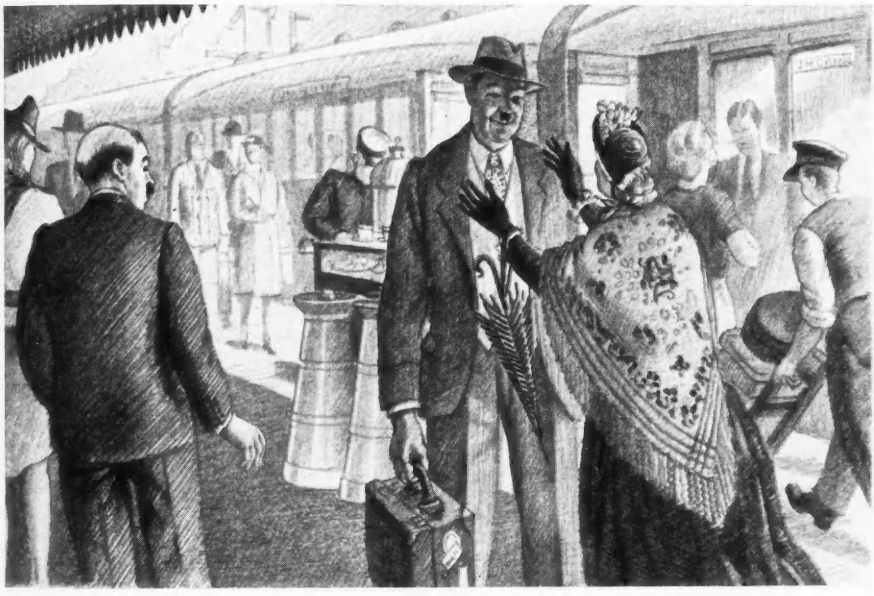
Philosophers' Stone of the ancient alchemists. You should be quite a famous man in the medical world. Do you occupy the chair of medicine here?"

"No," answered the man, being quite taken aback by this, "I am just a brakeman on this railway."

"Brakeman! You mean a brakeman..." exclaimed Mr Tompkins, losing all the ground under him. "You mean you—just put the brakes on when the train comes to the station?"

"Yes, that's what I do: and every time the train gets slowed down, the passengers gain in their age relative to other people. Of course," he added modestly, "the engine driver who accelerates the train also does his part in the job."

"But what has it to do with staying young?" asked Mr Tompkins in great surprise.



"Dear Grandfather!"

"Well, I don't know exactly," said the brakeman, "but it is so. When I asked a University professor travelling in my train once, how it comes about, he started a very long and incomprehensible speech about it, and finally said that it is the same thing as the 'redshifts'—I think he called it—on the sun. Have you heard anything about such things as redshifts?"

"No-o", said Mr Tompkins, a little doubtfully; and the brakeman went away shaking his head. A big, sombre-looking waiter came to his table with a bill, and

Mr Tompkins began to search in his pockets for change. Not finding any, he asked the gloomy waiter whether a cheque would do.

"No," barked the waiter, "give me cash!"

"But I haven't *got* any cash", said Mr Tompkins, getting a bit scared.

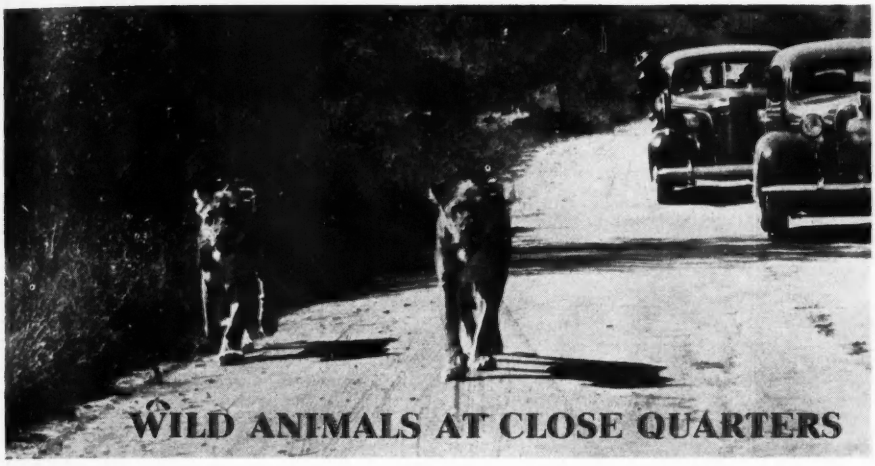
"Cash!" shouted the waiter, "Cash!...Cash it, please!" said the irritated voice again, and Mr Tompkins raised his head from the table. Across the table stood, not the gloomy waiter, but his old friend the professor, pushing a cheque towards him.

"Oh! I *am* so glad to see you!" exclaimed Mr Tompkins; "I just wanted to ask you if one can get eternal life simply by running round all the time?"

"Sorry, I don't get you", said the professor. "Will you please cash this cheque? I am in a hurry for a meeting."

Yes, in real life the old professor was much less friendly than in dreams. Mr Tompkins sighed, and started to count out the banknotes.

This photograph of the Small Eggar Moth, just emerged from its cocoon, is described in "Notes of the Month" on page 90



WILD ANIMALS AT CLOSE QUARTERS

BY LANCE HORNE

(The following article is taken direct from a letter from a young business man written during an adventurous holiday in the great Kruger National Park of South Africa. It was sent to correspondents who, the writer knew, would never visit the place themselves. It gives a vivid picture of the game reserve, by the indirect method of faithfully conveying the experience of an ordinary visitor. In one sense, it may be said to relate new facts, for the author's capacity for living vividly depended, like everyone else's, upon his never having seen such things before. It is the ordinary man's account of discovery, as authentic in its own way as an astronomer's account of adventures in the night sky.)

WE are just on the last lap of the most interesting and enjoyable holiday we have ever experienced. We started from Durban, a party of seven. We travelled in three cars: A. B. took a new Dodge car for the trip, N. M. took a new Nash and I took my Packard which had done 10,000 miles. I was particularly anxious that my car should give no trouble, as it was the only privately owned car in the party, and I had it overhauled before we started. Originally we were to have been nine in three cars.

It was arranged that we should meet at the Imperial Hotel, Maritzburg, at 8 a.m. on the morning of Sunday, 3 July. Briefly our trip was as follows: the first day we travelled through Maritzburg, Estcourt, Ladysmith, Newcastle, Volksrust to Erinelo in the Transvaal. The distance run was 356 miles without any incident worthy of note, and we were all ready to turn into bed at a comfortable hotel after a somewhat tiring journey. The other men exchanged drivers for a change, but I would always rather drive the car in which I travel, and so I drove mine throughout the trip except in the Game Reserve, where Alice drove it for me.

Erinelo is one of the highest places in the Transvaal, and when we awoke the following morning all around was covered with white frost, an uncommon sight for those of us who live down at the coast. After breakfast and our attentions to motor-cars we left for Barberton, an old mining town lying under the mountains in the Eastern Transvaal. The roads were particularly good, and, travelling safely and comfortably at 50 miles an hour, we reeled off the 130 miles to Barberton by 11 a.m. tea time. The only feature of the drive is the wonderful piece of road over the mountains and down the pass into Barberton, where we

A Kudu cow

dropped thousands of feet in a very short distance, and the road winds round incredibly sharp corners through rocky ravines covered by brightly flowering cacti.

We lunched at a place called Kaap Minden, quite near the Game Reserve, where, going out to my car to get some cigarettes, I saw a young lion standing beside it! I think I may perhaps be pardoned for flying so precipitately back to the shelter of the hotel stoep (by hotel I mean a corrugated iron shack standing quite alone in the middle of the veldt). It appears that a young farmer who had arrived at the place had caught the lion nearby when it was a cub, and had kept it as a domestic pet until now (about half fully grown) it followed him about like a dog. He hoisted the animal on to the bonnet of my car and I photographed it there. After lunch we proceeded into the Game Reserve at Malalene Gate. I must at this stage give you an idea of the Game Reserve. I confess that until I arrived there I was as ignorant of it as I have no doubt you are. I thought of a large park containing a number of semi-tame animals. Actually, the Kruger National Park (as it is called) is a piece of country comparable in area to that of England. It is about 400 miles long and of varying widths. Its boundaries are rivers on three sides, and the Lembombo Mountains on the borders of Portuguese East Africa on the fourth.

Since before the Boer War, game has been protected in this area, and has been left as wild as it ever was. Only in recent years has the area been thrown open to the public for the few winter months during which it is free from the dangers of fever. Roads have been constructed through the Reserve, and several rest camps have been established for the use of visitors. These rest camps comprise a number of white-washed mud-and-thatch huts in fenced clearings, with stores where provisions can be bought and blankets hired and where, in some cases, meals can be obtained.

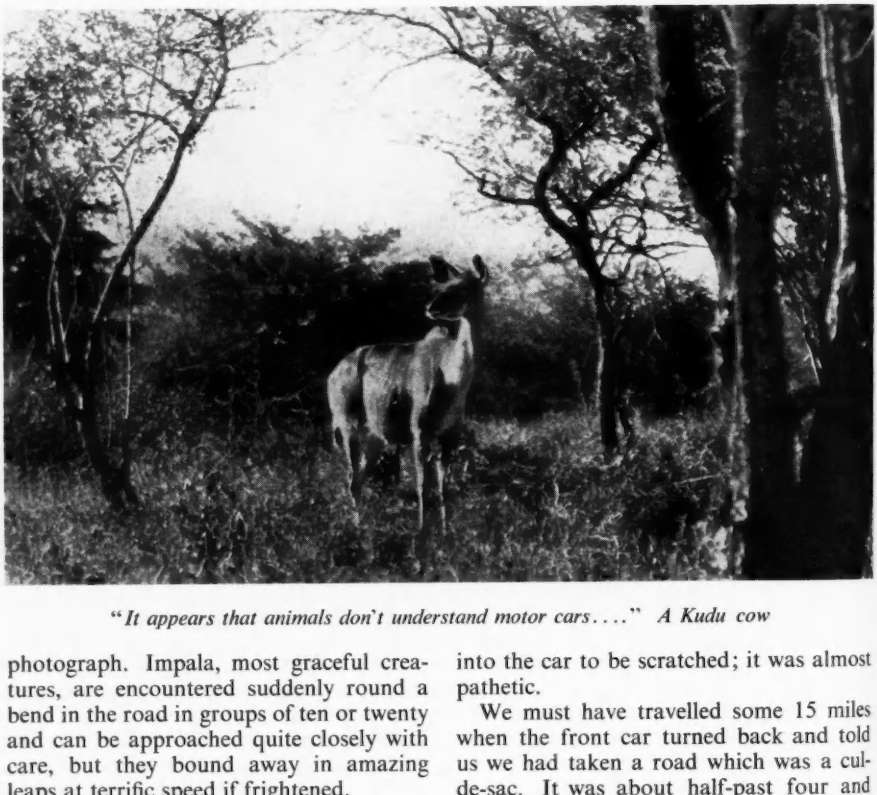
During July these camps are overcrowded

A Kudu bull, "most beautiful of animals"

and hundreds of tents are pitched within the fenced area. The regulations of the Reserve are very strict. At the gate of entry all firearms are sealed: they may be used in case of self-defence but a satisfactory explanation of the broken seal is required. In no circumstances whatever may one leave the road or get out of the motor-car outside a rest camp, except at a few, well-defined safety spots. The gates of the camps are closed just after sunset and opened just before sunrise, and heavy penalties are imposed on those who are not within the camps before the gates close. Accommodation in the rest camps cannot be reserved and the sightseers take what accommodation may be available as they arrive, so that one may be allotted a hut, or a tent, or even a tarpaulin, and numbers of people have been obliged to sleep in their cars during the busy periods.

Despite this rule I fortunately observed an obscure paragraph in the official guide book which advised that at Pretorius Kop —the biggest and most up-to-date of the rest camps—there were two thatched cottages which could be hired for £1. 1*s.* a night each, and could be reserved if paid for in advance. I paid up some weeks before we left and booked them for three nights, so that on our arrival at Malalene Gate we were happy in the knowledge that accommodation awaited us at Pretorius Kop about 45 miles away. A speed limit of 25 miles an hour is fixed within the Reserve, but actually this is far too fast to see the game. The whole country is covered with "bush", that is, bushes and short stumpy trees of thorn, and long brown grass. There must be masses of game in the Reserve, but the area is so vast that it is not immediately apparent to the visitor. We travelled from Malalene at about 10 miles an hour, and even at this speed I was unable to see buck standing in the bush just alongside the road until it had been pointed out to me. It is most thrilling to travel along at just over walking pace over a narrow grassy track

between the bush, searching the trees and little open glades which occasionally appear, for some animal, and then suddenly the car stops, and the driver, more expert than I, whispers, "Look! on the right", and there, standing motionless, a few yards away watching us and ready to spring away into the bush at the first sign of danger, stands a great Kudu bull, most beautiful animals as you will see from the photograph. Impala, most graceful creatures, are encountered suddenly round a bend in the road in groups of ten or twenty and can be approached quite closely with care, but they bound away in amazing leaps at terrific speed if frightened.



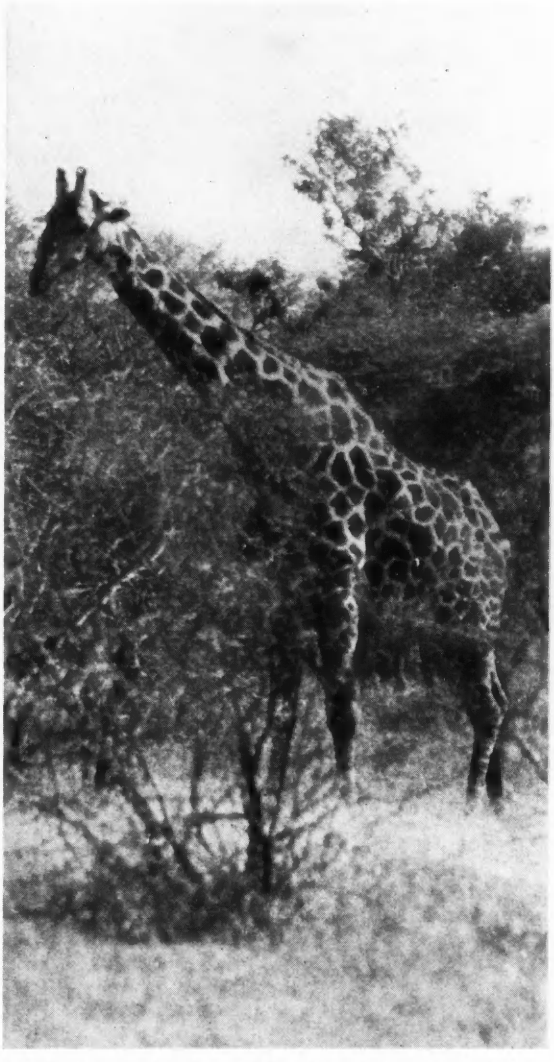
"It appears that animals don't understand motor cars...." A Kudu cow

It appears that the animals don't understand motor cars; they don't connect them with human beings, whom they cannot identify inside them, and they have learned to look upon them as harmless, but if a passenger should leave the car the animals would bolt or attack according to their natures.

I think perhaps this first hour or so in the Reserve is a thrill one will not again experience. Seeing wild animals, really wild in their natural surroundings, is so entirely different from seeing them half-tame in small enclosures. I say this with much conviction because, some time after this in Rhodesia, I visited a small game park perhaps a square mile fenced in, where buck and zebra came up and poked their noses into the car to be scratched; it was almost pathetic.

We must have travelled some 15 miles when the front car turned back and told us we had taken a road which was a cul-de-sac. It was about half-past four and the gates closed at Pretorius Kop at 5.40. We held a hasty council and decided to dash for it and ignore all speed limits. The girls who had been driving the cars relinquished the wheels, and we took over. I had Mrs A. B. in my car, Alice was with A. B., and the others were with N. M. Here began the most thrilling drive

I have ever experienced. The animals which hide in the bush during the heat of the day come out at about sun-down and drink and disport themselves, and everywhere the roads were, I was going to say, "infested" with them. The roads were merely tracks winding through the bush and crossed every here and there by deep "dongas", that is, a ditch about 20 or 30 ft. deep and perhaps 50 yards across, which is really a small river bed. My one anxiety was that I might break a spring or turn the car over, for we were undoubtedly dashing round corners and approaching hazards much too fast to take them carefully. Mrs A. B.'s main worry was her husband, though what she thought would happen to him I don't know; she also feared, not without good cause, that I should run down some of the poor frightened creatures that continually bounded across the road in front of the car. Throughout the drive the setting sun was shining full in our faces and blinding us. At last we sighted the camp like a native village in the distance, and we just got in as the gates were closing. A. B. and Alice, who had preceded us by about 100 yards, were just in, but there was no sign of the others. As I drew up in front of the office place I saw the front of A. B.'s car all bashed in—he and Alice, travelling at about 40 miles an hour, had hit a wildebeeste, fair and square in the middle of the road. The animal had charged across the road in front of the car, just too late. We did not know what to do because the incident was likely to involve us in some trouble; after consideration, remembering the certainty that the wildebeeste would undoubtedly be only one of hundreds to be eaten that night, we decided



In this photograph of a giraffe, taken with a telescopic lens, the apparent haziness is actually very fine thorn bush, on which the animal is browsing

"Sat in a row in the road"

to say nothing about it. I went to the office to find a crowd of people waiting to receive our accommodation which had been promised to them if we did not arrive before the gates closed. As I was paying the final fees a policeman came down for the keys, and let the superintendent know that a car had opened the gates and come in after he had closed them because he had not had the keys. The superintendent replied, "Good luck to them! I'm busy, lock the gates now." The offending but fortunate car was the remainder of our party! So all was well that ended well, and we sat in the gloaming and drank our whiskies-and-sodas with relish and satisfaction. We were soon in bed, and up in the dark next morning to be at the gate at 5.30, eager to get out and see the game—that being the most favourable time to spot them. It is eerie to lie in a little hut and hear through the stillness of the night the roars of lions at a kill. I had always been a bit sceptical about that, but I need not have been. The noise of carnivorous animals is unmistakable, and it does not call for any straining of the ears. Later on I saw a leopard devouring a buck it had just killed; and everywhere one sees the bones of animals picked almost clean by hyenas and jackals, and finished off by vultures.

We spent two days at Pretorius Kop touring round and returning each night to sleep. We then went on to Letaba, and the next day out of the Reserve. We spent three days in the Reserve altogether, and were fortunate in seeing a great variety of game. This is largely a matter of chance, of course, but a patient and careful search does not go unrewarded. Actually we travelled 457 miles in all in the Reserve on this visit. I shall not for a long time forget my first sight of lions. Two lionesses accompanied by cubs were beyond the long grass, sitting on a slab of rock about a hundred yards away. Several cars had already stopped and we manœuvred for position to see the lions. I changed the lens of my Leica camera to a "Telyt"—a telescopic lens—to try to get a snap of them. I had just got it fixed up when they came through the grass towards us. I tried to replace my other lens but lost my head with excitement, and failed. Eventually one lioness appeared in the grass about five yards from me and after staring at me for a moment or two, walked past with great dignity, the cubs following: some distance in front of the car the lioness crossed the road and disappeared into the bush on the other side; but the three cubs sat in a row in the road and looked at us whilst I managed to get a picture or two of them. The lion is rightly called the king of beasts, and he knows it. Even the elephant is inclined to be timid, but the lion treats all he encounters with a quiet and dignified contempt, and the swagger with which he will walk in front of a motor car, as though he knows very well that it would not dare to hurt him, must be seen to be believed.

We left the Reserve at Malopene, having travelled through less than a third of its length, and went by way of Tzaneen through

"And after staring at me for a moment, walked past with great dignity"

Impala, most graceful and agile of all buck

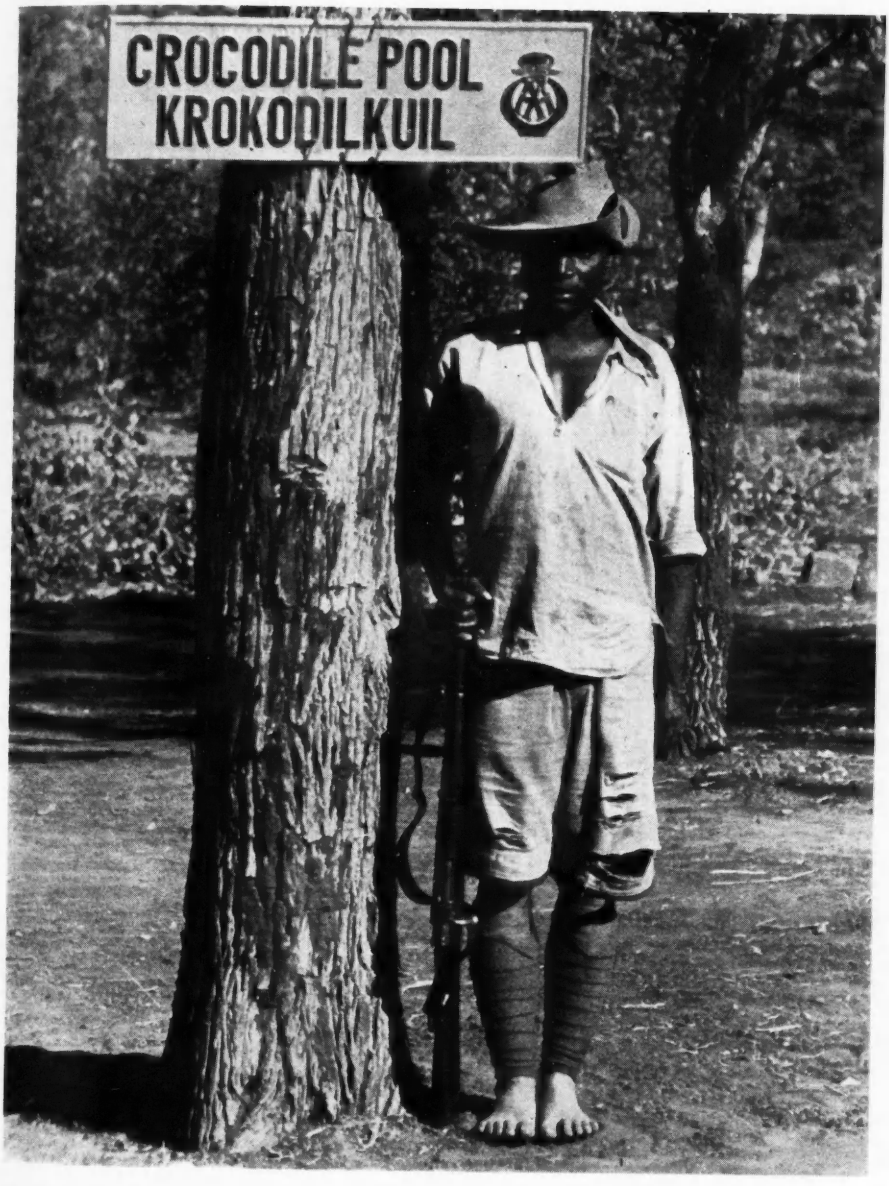
some amazing mountains to the very north of the Transvaal.

The next day we left for Bulawayo in Rhodesia. We had to stop at the famous Beit Bridge over the Limpopo River for customs' formalities, and arrived at Bulawayo, tired after a 300-mile drive, at about 6 p.m.

African rivers are amazing. In summer they are really big, by which I mean like the Thames in the City, but in winter, with a few exceptions, they are stone-dry sandy beds. The Limpopo, which runs for hundreds of miles and is the boundary of Rhodesia and the Union of South Africa, and is very considerably wider than the Umgeni at Durban North, could have been walked across without getting our feet wet when we arrived.

From Bulawayo we went on, 300 miles in a day, to the Victoria Falls. I feel that it is useless to attempt to describe the Falls: the main difficulty is that you can't see them. Imagine a river, a mile and a half wide, and deep enough to take quite decent-sized passenger boats, suddenly falling hundreds of feet into a narrow ravine only a hundred yards across, through which the fallen water flows at right angles to its original course, looking like treacle because of its unknown depth. The noise of the fall is a deafening thunder, and the spray rises in an enormous cloud high into the sky. This spray cloud can be seen many miles away, and it falls like heavy continual rain over a large area near at hand. Unfortunately it is this spray that hides most of the main falls, and one can only clearly see the smaller sections, though these are terrific enough in all conscience. The only way to see the complete Falls is to fly over them.

From Victoria Falls we returned to Bulawayo and on the next day to Salisbury, where the party broke up. Alice and I went on alone by easy stages to the Zimbabwe Ruins. Birchenough Bridge is a magnificent sight. It is a suspension bridge over a big river and connects Umtali and eastern



A native ranger, the escort provided at one of the very few places where visitors are allowed to leave their cars: the rifle is necessary as a protection from lions which may be lurking in the bush

Rhodesia with the Union. It is at least 100 miles from any village or trace of civilization, and rises in an enormous arch visible for many miles in the middle of the veldt. The Zimbabwe Ruins are one of the great mysteries of Africa—strange temples and fortresses, of great but unknown age, obviously relics of some vanished civilization, but no one could tell us by whom they were built or with what object. They could not have been built by any of the native tribes known to have inhabited Africa. They are sometimes attributed to Indian, or Arabic, or Egyptian civilizations, but no one knows. They stand in the centre of Africa in an amazing state of preservation, an unsolved mystery perhaps for all time.

From Zimbabwe we turned back into the Union to our old mountain inn at Louis Trichardt (268 miles) and the next day we went back into the Game Reserve at the extreme northern end on the borders of Portuguese East Africa. We spent four days quietly cruising down the Reserve from Punda Maria to Crocodile Bridge, and I must confess that we enjoyed it more and saw more than we had with the party. With a party, for one thing, it seemed to be always necessary to be at certain places at meal times. That lunch is served at one o'clock is one of the most destructive laws of modern civilization. Alice and I did not starve; but we ate when there seemed to be nothing better to do, and if we were in pursuit of game we thought nothing of breaking fast at 11.30 a.m. and lunching at 7.30 p.m. We took tinned food and could thus stay at small and little-frequented camps where food was not available.

At Shingwedsi we went down to the Crocodile Pool. Under the protection of an old native ranger (armed with a rifle in case of lions in the bush) one may creep down to the river bank to see the crocodiles basking on the rocks. They are very timid beasts, and at the slightest disturbance will slide noiselessly into the water. Tall reed screens have been built behind which one may creep, and while I was standing behind one of these, poking my camera lens between the reeds, there was a sudden great splash at my feet. It was only a turtle; but the crocodile on the bank, whose photograph I had been trying to take, was disturbed, and slid into the river.

One evening we came upon traces of an elephant. Elephants are rare and we had not hitherto seen signs of any. He had pushed a few fair-size trees down across the road and his dung was everywhere. We drove slowly on, excitedly looking into every break in the bush, when suddenly round a sharp bend in the bush there stood the enormous beast at the side of the road, so close that, by the time Alice had stopped the car, I could not get him all into the view-finder of the camera. I implored Alice to stop the engine because the light was poor and I wanted to rest the camera against the car to give a slow exposure. Alice was all for driving on before the brute gave us a playful kick and knocked us flying. You know the narrow limits of my courage—not too keen on cows you know—but the enthusiasm of the photographer overcomes these little qualms, and I persuaded Alice to stop the engine. Meanwhile the great beast stood just alongside, looking ten times bigger than any elephant should, and gazing at us as if not knowing quite what to make of us. Then he gave a terrific snort and shook his enormous ears at us, emitting clouds of dust; and while Alice in terror was trying to get the car started, he quietly walked behind us with a few long slow strides and disappeared into the bush! A car that had passed a few hundred yards in front of us had not seen him, and a car that arrived on the scene a few minutes later missed him also.

The next morning, a little farther along the same road we turned a corner to see a full-grown lion walking slowly along the road towards us! We pulled up, and I spent a few feverish minutes arguing with Alice about backing out of the way or stopping the engine, and leaned out of the window trying to get a focus on the advancing majesty. The lion was quite unconcerned. He came up to within a couple

of yards of the car, stared at me out of his greeny eyes as if I had got a most frightful nerve to be there—the sort of look one would expect from the Duke of Thingmebobb on arrival at his ball in a lounge suit—and, with utter disdain and great dignity, turned his back on us and sat down in the grass, looking the other way, about ten yards ahead. Unfortunately he did not care that we should not be able to travel fast. But the places on route were so uninviting that we pushed on and on and got here the same day, having driven for thirteen consecutive hours.

Yesterday we went fishing in a lake in an outboard flat-bottomed boat with a native in charge. On our way to the fishing spot the water narrowed down to a place about

"Gazing at us as if not knowing quite what to make of us"

to turn round again; I fear that the photograph of his face, whilst he was advancing towards us, will be out of focus.

Having a couple of days of our holiday left we decided to come here (St Lucia) for a little quiet fishing. Alice felt that she had had enough excitement for a while. We went direct through Swaziland, a matter of 360 miles. We left early in the morning, intending to take two days for the trip, not so much for the distance but because, owing to the condition of the roads, we anticipated 200 yards across and in the middle were about a dozen hippopotami. Alice, after the Reserve, thought she had had enough of this sort of joke. The boy was quite raw and couldn't speak English. I tried to find out if the beasts were dangerous and only elicited the reply that one of them was "cheeki", a Zulu appropriation of an old Cockney word used by them to mean aggressive. Of course, I was terrified myself, but as Alice did all the trembling for me I could do the brave and daring without

much fear of my heroic suggestion being adopted. I comforted myself that the authorities usually take pretty good care to protect the public, and there were certainly no notices up in the hotel saying "Beware of Hippo" and I decided to go on. But when the boy stopped the engine and began to pull the boat cautiously through the reeds, eyeing the hippo fearfully all the time, and when the beasts rose up in the water and barked at us and then disappeared under the water and reappeared appreciably nearer, I thought it best to be gracious and fall in with Alice's wishes, so we abandoned our fishing and returned in some haste.

We have since heard that the animals are quite harmless, and have not been known to attack boats here. We are now only 200 miles from home, where we are returning the day after tomorrow to see our bairns—for whom we are both feeling a bit homesick. I see that we have done nearly 4500 miles this month; it gives you some idea of the vastness of Africa.

Colour in Painting

By Mary Barne

II. Harmony

(In this article, the second in the series, of which the first, "The Importance of Colour in Art", appeared last month, Miss Barne explains colour ratio, and the combination of hues. Next month she will conclude with "Balance of Tone, and Quality of Colour".)

Except the violet and the very dark red, at the extreme ends of the spectrum, both of which are dull from lack of luminosity, each one of the chromata, seen in fairly pure quality, is beautiful in itself. But every hue can become ugly, and make its neighbours ugly, if they form a discord. The analogy with musical notes is here exact. I find in many people an antipathy to "magenta" (crimson-purple); this is probably because, unconsciously perhaps, they think of flowers of this hue among vividly green leaves—an ugly contrast because too violent, these hues being complementary. As a matter of fact, magenta flowers, also pink and purple ones, in a wild state at any rate, usually have leaves that are more grey than green.

There are extremely few colour discords in Nature. Take the case of flowers and their leaves that I have just cited. And do not blue sky, golden-green foliage, and red-brown earth form a lovely chord, as satisfying as the "major triad" of a musical scale? In a seascape, the sky and sea may appear to be of two different blues, which, in theory, should clash; but, in fact, the sky's blue is reflected on a portion of each wave, so, looked at from the right angle, the two blues are identical.

The typical North-European blonde has harmonious colouring: yellowish hair, red cheeks and lips and blue eyes; sallow types usually have greyish green eyes that "carry on" the faintly greenish tinge of the skin; blue eyes in a sallow face are as uncommon as unpleasing. (So are greenish eyes in a face made-up to imitate the blonde's pink skin.) An endless number of such facts may be observed, of such everyday occurrence that, perhaps, few have troubled to notice and admire them.

The sense of colour harmony is born in some artists; but, just as is the case with those with a natural "musical ear", this innate sense leads them, usually unconsciously, to follow rules. For, as Delacroix would say, *il faut de la raison*. Let us try to find and formulate these rules. They are vaguer, and less generally accepted, than those governing the art of music, but they certainly exist. Why they are somewhat vague, and followed unconsciously, is owing to the lack of standardization in the names of hues. Where would music be, if we had fancy names for the notes of our scales? "Middle C" means a note of the same wave-length to singers all over the globe; I purposely say "singers", because, owing to "temperament", a note of the same denomination varies slightly on different kinds of instruments, and even on different pianos. But "scarlet" means to one man a hue of the same wave-length as that which another calls "crimson"; and as for "orange", I suppose oranges have twenty or more different hues (I do not speak of shades or tints) varying with their ripeness and place of origin. And so on.

One of the most wrong and misleading names ever given to a hue was "indigo"—by which Newton meant a very decided, and (for the trichromatic theory*) very important colour. Ultramarine is the pigment that best represents it, between mid-blue and violet, whereas indigo is a *greenish* blue dye.

I believe the Royal Horticultural Society now has a standard list of hues; and that there are lists of hue names in many schools. Dyeworks, too, have their lists. And there are the colossal systems of the American Munsell, and the German Ostwald. These theorists have charts in geometrical form (Munsell a sphere, Ostwald a double cone) with which they indicate definite numbers of shades and tints for each hue. But surely, if all, or any, of these lists differ (as they certainly do), do they not make confusion worse confounded?

Of course, the painter has the names of his pigments as a standard, or should have; but Herr Max Doerner, in his book *Materials of the Artist*, writes that in artists' colour catalogues he has found many instances of different pigments listed under the same name, and also a long list of arbitrarily chosen names for one and the same pigment.

Let us, then, do a little standardizing for ourselves. With the help of a spectroscope with calibrated scale and pointer, I, and many others before me, have found, as nearly as possible, the exact wave-lengths of the chief spectral hues. Take an arbitrary scale of twelve hues or chromata (ten spectral, and two formed by mixtures in different proportions of the hues at the two ends of the spectrum). Most people would recognize these twelve as principal ones, and they correspond, roughly, in the intervals between their wave-lengths, to the twelve semi-tones of another arbitrary scale: the chromatic in modern European music. Let these twelve hues be as follows:

(1) Spectral red (a deep blood-red).
(2) Orange-red or scarlet.
(3) Yellow-orange.
(4) A "cool" yellow.
(5) Leaf or moss-green (a "warm" green).
(6) Jade (or bluish) green.
(7) Peacock-blue (a blue that is almost green).
(8) Cyan-blue (its paler tints are known as "sky-blue").
(9) Violet-blue or ultramarine.
(10) Violet.
(11) Purple.
(12) Purplish crimson or "magenta".

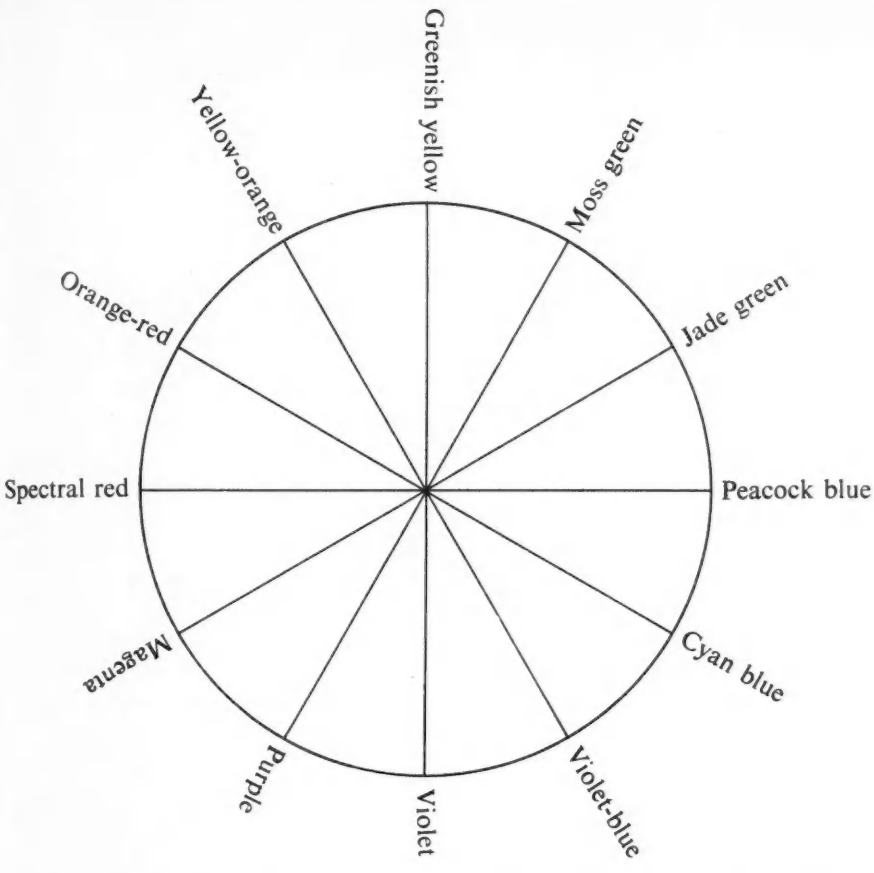
Their wave-lengths in Ångström units are: (1) 6900; (2) 6390; (3) 6130; (4) 5750; (5) 5520; (6) 5150; (7) 5000; (8) 4810; (9) 4420; (10) 4140; (11) and (12) are non-spectral hues.

For simplicity's sake, I shall quote these twelve hues, in the remaining part of these articles, by the numbers I have given them.

Here, the analogy with music will help us further. Intervals of less than three semi-tones form discords; so in colour, and in music, there is another discord, perhaps the harshest of all: the so-called "tritone" (interval of six semi-tones). This is occasionally used, especially in contemporary music, always, I think and hope, with immediate resolution; but it occurs in none of the six major and minor triads; it is also unmelodic, for the two notes that compose it do not both occur in any civilized scale whatever, ancient or modern (except, of course, the chromatic, in which *all* occur).

Now arrange the twelve hues in a circle. Those that are opposite each other will be found to be complementaries, that is, combined in the proper proportion on a colour disc, or in the form of lights thrown on a screen, they will produce white. [Complementaries can also be found subjectively, by gazing fixedly at a bright hue for half a minute or 40 sec., and then at a sheet of white paper—on which its complementary will at once appear; but this

* This being one of the three hues to which (according to that generally accepted theory) three different kinds of nerve-ending receptors in the retina respond; and by mixtures (of lights) of which, all other hues can be produced.



method, as it depends a little on pigmentary matter, which may vary with age or illness, in the eye itself, is less reliable.]

Now, the ratios of the wave-lengths of the concordant hues to one another are all simple, i.e. they may be expressed in small numbers; but the discords have complex ratios, and those of the complementaries (all closely similar ratios) are the most complex of any, being in the neighbourhood of 18 : 25, which is that of the musical tritone. It does not follow that the intervals with the simplest ratios are always, and to all ears, the most pleasing, either in colour or in music; for, just as the major third in music (ratio 4 : 5) gives many people more pleasure, being fresher and more piquant, than the fifth (ratio 2 : 3) which is slightly dull and commonplace, so blood-red seems to have rejoiced the Venetians more, when seen with warm green, than with its more concordant hue cyan-blue. All I say is that, in both arts, the undoubted concords bear the simplest ratios to one another, as do the harshest discords the most complex.

The reason for the discordance of certain musical intervals is, of course, well known: the synchronizing notes carry too many harmonics or "over-tones", which excite too great a number of the ear's nerve-

endings all together and produce "beats" and clashes. In colour, the reasons for concord and discord have not yet been fully ascertained, but it is certain that most objects, and, above all, pigments, reflect very "impure" light, by which I mean light from more than one point of the spectrum. Yellow light, for instance, is often a mixture of red and green which is indistinguishable from the yellow of the spectrum. Even "in the spectrum itself, if it be one formed by refraction through a prism, the illumination at each point does not always consist of light of definite wave-length" (I quote the late Lord Rayleigh). It is not perhaps surprising, therefore, that many colour combinations are unpleasing, and especially complementaries, which can have no harmonics in common.

Why the concordant intervals, both in colour and music, should be those with the simplest ratios, is more curious. Far be it from me to attempt an explanation; but there is a reason for everything, and psychology may some day discover the cause of this invariable rule.

Let us be content to say that anyone with the slightest colour sense (and no knowledge whatever of such things as colour wave-lengths) feels that two hues very near each other in the spectrum—say (5) and (7)—form an unpleasing combination, or "kill" each other, as the saying goes. And it will be found that two complementaries, say (6) and (12), form so violent a contrast as to appear harsh and crude when juxtaposed. Yet many colour-harmony systems, including Ostwald's, advocate the juxtaposition of complementaries, to form a "balance". I do not think it is a question of balance; Reynolds said, in one of his "Discourses": "Some excellences are of a discordant nature; and the attempt to join them only produces a harsh jarring of incongruent principles. The attempt to unite contrary excellences can never escape degenerating into the monstrous, but by sinking into the insipid." Whatever may be thought of some of his dicta, this one seems to me to be eminently true of complementary hues. Seen together from a short distance, they are monstrous; mixed optically (as may be done by viewing the juxtaposition from a sufficient distance) they neutralize each other and become colourless. As Mr Adrian Stokes well puts it (in his interesting book *Colour and Form*): "Complementaries are rivals whose aim is to clash, annihilate each other, and find the Nirvana of white or grey."

As regards dyads, I think the principles of colour harmony are simply these two: any two hues, less than 90° apart in the colour circle, form a discord when seen together, that is, together and *alone*, for, seen with a few more neighbouring hues, they form the "harmony of kinship" I mention a little later, and so do any two that lie exactly opposite in that circle. These rules permit the colour chords corresponding roughly to musical major and minor thirds, fourths, fifths, and major and minor sixths, to be used; that is: with each hue, six combinations may be formed—i.e. seventy-two in all; taking into consideration all the shades and tints of each hue that may be employed, there is surely space here for variety enough, even if only these twelve hues be used; and, of course, there are very many intermediate gradations.

From the concordant dyads we may pass on to triads. In the six concordant triads (three major and three minor) of any musical scale, the chords are in each case formed from three notes, each one of which is in harmony with each of the others. Now, it will be found that in not one of the six cases, in music, are the notes equidistant in the chromatic scale, which leads us to the conclusion that the same thing probably holds in colour; and it certainly does. Just as any two complementaries contrast harshly, so do any three hues equidistant, i.e. exactly 120° apart, round the colour circle. From this, and the second of the two rules governing harmony of dyads, a general rule may be deduced: any number of hues, which, in the form of lights thrown, in their proper proportions, on a screen, will form white, are discordant in juxta-

position. The principal colourist schools of painting—the Venetians, the Japanese, the Dutch, Velazquez and his small coterie, later the English and the French—did not attempt to "balance" their hues.

The Venetians used principally the triad (1), (5) and (8)—a cool harmony, the red giving the needful touch of warmth. These three hues occur again and again in their paintings; in the Madonna pictures, the Virgin's robes are of hues (1) and (8), (5) being introduced elsewhere, very often as a curtain behind the figures, sometimes as the prevailing hue of a landscape background. The dyad (1) and (5) was loved by this school: Giorgione, in fact, in his great altar-piece at Castelfranco, breaks so far away from convention as to clothe his Virgin in these two hues instead of in red and some hue of blue; he completes the triad by introducing a large space of sky of a very delicate pale tint of (8). The fine effect of this triad, on a large scale, and with other harmonizing colours, may be especially observed in Paolo Veronese's "Alexander and the Family of Darius" (National Gallery), where the chief hues are repeated many times throughout the great length of canvas.

The favourite Dutch triad consists of hues (1), (4) and (8). It is no wonder that the inhabitants of a damp and chilly country have favoured a warm colouring. Yet this yellow is so cool (though deep in tint) that the whole effect is that of richness without "hotness". In de Hooch's works, and those of many others of this school, a great deal of red, and, as with all good colourists, very little yellow is introduced; but, in the exquisite paintings of Vermeer, the greenish blue so predominates over the other two hues, that the effect is very cool and delicate. Rembrandt worked a great deal in rich schemes of (1) and (4), combining them with much non-spectral colour. It is very rarely that one sees any chroma, besides these three, in a Dutch picture. And I think it may be called the "Low Countries triad", for reds, yellows and blues (of all sorts, used without much sense of harmony) preponderate in Flemish paintings and in their stained glass, fine examples of which may be seen over here in Lichfield Cathedral. Watteau, though a Fleming by birth, was an excellent colourist; and he used the "Dutch triad" as the foundation of his colour schemes, usually combining with it other harmonizing hues (sometimes purple which has now, alas, faded to a washy lilac). Two, at any rate, of the great Venetians, occasionally used this "Dutch triad": Gentile Bellini and Tiepolo. The latter made very frequent and striking use of it.

Velazquez's favourite triad was, I think, the same as the Venetians', but with a red inclined more to crimson. A frequent arrangement with him was: (5) very much neutralized, as background, a good deal of his velvety black, or warm browns and greys, and small touches of the other two chromata introduced here and there with telling effect.

A chord which may be called the "English triad" consists of (2), (6) and (9). It was certainly much used by Constable in his landscapes, the chromata of which usually consist of a cool green for the vegetation, a thunderous ultramarine for the sky showing between storm clouds, and touches of scarlet to clothe his figures.

The Japanese designers of colour prints—great masters of harmony—had often a strange but beautiful chord: (4), (5) and a pale tint of (12) (rose-pink); this reminds one of the chords of old harp-music.

There is another kind of colour harmony, which may be called "harmony of kinship", to which I referred on page 84. It is that produced by juxtaposition of several hues from the same part of the colour circle, either arranged in their proper order, as in Nature (in the rainbow, spectra, etc.), or else so disposed in a painting by some master colourist that the whole seems to be dominated by some one hue that occurs several times over in the picture, and light from which is partly composed of, or partly composes, the other chromata. A striking example of this is Delacroix's small "Execution of Marino Faliero" in the

Wallace Collection, a beautiful work, though grim enough in subject; the colouring ranges from (1) to (6); all the hues being those that could, by combination of lights, form yellow (though little pure yellow pigment is used), the picture is suffused with a golden glow. This, as in all such cases, makes for unity—which, at bottom, is identical with harmony. Rembrandt made much use of such harmonies as these; he called the hues near each other in the spectrum "friendly colours". Piero della Francesca's "Nativity" in the National Gallery is another example of "kinship harmony", blue being here the harmonizing hue. If such a picture as this is viewed from some distance (which must, of course, vary with different individuals), the various but "friendly" hues blend into one by optical mixture—in the case of Piero's masterpiece into a soft grey-blue. Cima's "Crucifixion" (in one of the Loan Collections in the same Gallery) is a still lovelier "Symphony in Blue". In Velazquez's baby "Don Baltasar Carlos", the chromata are also "friendly colours", and all very low in tone; the effect, at some little distance, is of a cool glow like that of a honeysuckle flower.

Mr Edwin Glasgow, in his valuable and delightful book: *The Painter's Eye*, says that the principles of harmony and design, pushed to their extremes, end in the abstract patterns of the decorator. So logically, they should; but, unfortunately, in the contemporary "abstract" paintings that I have seen, principles of colour harmony, far from being pushed to any extreme, are left out altogether, with devastating effect. This is much to be deplored, for one of the most useful applications of these principles should be in decoration, and abstract design generally.

(To be concluded)

Francesca's "Nativity"

Notes of the Month

"National Defence and the Scientist"

LECTURING to a gathering of scientific workers in London on 12 December, Professor Bernal divided the scientific problems of national defence into two groups—political and technical—the latter demanding special research into both military and civil problems. He attributed the trouble to the fact that both aspects of national defence become acute at the same time, during a crisis, and it is therefore very necessary that scientists should now study the technical side of defence, at the same time making sure that it is true democracy that they are defending.

Dealing with the technical aspect first, he expressed his belief that, in view of conditions in China and Spain to-day, a war of attrition is most unlikely, owing to the perfection of modern defence methods. He said, also, that the chief feature of prolonged warfare is likely to be a disorganization which could only be overcome were civil life already flexible. For this the urgent needs of to-day are those of keeping the population alive, maintaining industry, building up a passive defence, perfecting military and medical research, as well as building up a morale and efficient organization.

Professor Bernal emphasized the need for research in all these sections, saying that we should concentrate on the weak points immediately, at the same time planning a long-term scheme of research into the problems of national economy and new methods of production.

For the use of industry science must be organized, and this involves the problem of finance. Judging from the papers published, 90 % of research in this country has an academic source of finance, whereas only 2 % is supplied by industry. In the past, research has been inspired mainly by our war needs, but still we lack research in many fundamental branches, including metals, light engineering, and transport. Of the $2\frac{3}{4}$ million pounds spent on research by the Government in 1937, less than half was devoted to scientific work. In Professor Bernal's estimation we need ten times this expenditure. The Government's science register of universities only covers 15–20 % of the available scientists. An investigation of the available laboratories would be of great value in that it would enable the work to be distributed wisely without undue movement of the scientists or disturbance of existing necessary work. It is up to the individual scientist to study the situation and to enlighten the public as to the true outlook.

Unfortunately over 70,000 chemists in industry are isolated and not organized into the powerful thinking body that they might be. This, said Professor Bernal, was the work of such bodies as the British Association of Chemists and the

Association of Scientific Workers. The latter body upholds that the control of research at all times must be democratic, not military, allowing the scientist a right to give helpful criticism. He pointed out, too, that the unit of research should be the laboratory, not the scientist, who, however, should maintain his freedom of conscience.

Fish-wool

The fisheries of England are well on the way to rivalling the coal industry for the variety of their by-products. To every fisherman, there are four landsmen engaged on distribution and by-products. Only first-class fish are sold for eating; the offal from these is converted into isinglass, glues and ink. From the livers of dog-fish, cod and halibut, oil is extracted which is rich in vitamins. Large quantities of good quality fish are sent to the fish-meal factories, where they are converted into feeding stuffs for chicken and pigs. Fish of a lower grade go to the fish-manure works.

The latest synthetic substances obtained from fish are fish wool and "white of egg".

At the moment it seems that the work of scientists in totalitarian states is devoted entirely to the invention of new synthetic processes. From Italy comes news of another of these bright synthetic ideas. It is a claim to have manufactured a form of wool from fish, which is said to be used in the textile industry. In Germany, there is actually a factory operating in Hamburg for the extraction of albumen, or "white of egg", from fish. Albumen is a protein which occurs, in slightly different chemical forms, in most animals. As far as food value goes, there is little difference between albumen from fish and the white of a hen's egg. If the German process proves practical, there is no doubt that it will be installed in England, and instead of the albumen merely proving a nuisance by making fish markets slippery to the feet, it will find an economic use in confectionery.

"Missing Links" in the Vegetable Kingdom

Recent discoveries have shown that there are connecting forms among plants as significant as those which are so well known among animals. The former, however, have hardly yet won their way into popular evolutionary literature.

The sudden appearance of well-developed land plants in the Devonian period, and the absence of fossils indicative of more than remote relationship to the lower aquatic or semi-aquatic species, was long a puzzle to botanists. But the gap has been tolerably filled by the unearthing of an early Devonian flora, the Psilophytales.

Here we have smallish, simple, upright land plants, such as *Rhynia* and *Hornea*, that were destitute of both leaves and roots. The basal part of the stem was under-

ground (a rhizome), and on the lower side had groups of hairs which absorbed liquid food from the substratum. The aerial stems possessed stomata on their surfaces, a little conducting tissue within, and bore at their tips simple spore sacs containing large numbers of spores.

Asteroxylon was on the whole considerably more advanced. Though its rhizome was simple and rootless, the aerial well-branched stem was clothed with small simple leaves, without veins but having stomata, and the conducting tissue was more highly organized.

A fourth genus, *Psilophyton*, which gives its name to the group, was discovered by the famous geologist, Sir William Dawson, as early as 1859, but his account was not accepted by botanists. This was also a rootless plant without obvious leaves, though the spines on the stem may represent the foliar organ.

These fossils—which possess characters relating them not only to the Algae but to the Moss and Fern groups—are now regarded as being among the most interesting and important of all plant remains, as they demonstrate a very early, if not the earliest, stage in the floral "conquest of the land".

Another gap long existed between the reproductive organs of the non-flowering and the flowering plants. Darwin referred to the sudden appearance of ordinary flowers as an "abominable mystery". The discovery of the Bennetitales has, however, supplied an important link. Among these we find, instead of the usual separate sexual organs (with which the pollen-showering male apparatus and the female cone of our living pines have rendered us familiar), a bisexual flower, of a primitive kind, but built on the same general plan as that of the ordinary flowering plant. The outer portion consisted of bracts; next was a ring of stamens, in some cases very like fern fronds, with numerous spore or pollen sacs attached; in the centre was a "pistil", bearing on its surface naked ovules. Older specimens, from which the stamens had disappeared, show that the persisting bracts closed in round the seeds, forming a kind of seed case or fruit.

Further evolution produced in the Cretaceous period typical angiospermous flowers. And we here contemplate what Dr Scott describes as "the greatest change which the Kingdom of Plants has ever known", one by which "the whole face of the earth was changed", and one that was "almost comparable with the advent of Man in the animal record".

(*From J. Reeves.*)

Dr George Barger

On 5 January Dr G. Barger, F.R.S., Regius Professor of Chemistry in the University of Glasgow, died suddenly in Switzerland at the age of 60. He will be remembered particularly for his researches in alkaloids and for the work he did in synthesizing biological compounds. One of his many contributions to scientific

literature is his monograph *Ergot and Ergotism*, which deals with poisoning from *Calviceps purpurea*, the fungus whose reproductive body, known as ergot, sometimes infects rye bread.

Small Eggar Moth

February is the only month in which the Small Eggar Moth (*E. lanestris*) will emerge from the chrysalis. If conditions are not propitious for its emergence it will not appear until the February of the following year, sometimes even postponing its appearance for several years; it has been known to wait eleven years and then to come out successfully. The photograph on p. 68 shows the Small Eggar Moth just emerged, after remaining three years in its cocoon.

Science Masters at Cambridge

The thirty-ninth annual meeting of the Science Masters' Association was held at Cambridge from 3 to 6 January.

The Presidential address by Professor James Gray, in which he urged that the teaching of science should be more closely correlated with that of other subjects, was followed by some unusually attractive and well-attended lectures. Professor E. V. Appleton's subject was "Terrestrial Magnetism and the Sunspot Cycle". He explained how, as a result of observations made at the end of the last century by an amateur (Carrington), a definite connexion between magnetic variations and sunspots was established, and said that the theory held to-day was that daily magnetic changes are due to electric currents in the upper atmosphere consisting of electrons ejected from the sun and undergoing the tidal movements of the air. This theory has been confirmed by radio experiments. The existence and position of several electrical layers has been established, and also their vertical tidal motion. Experiments conducted continuously during the past eleven years (the period of the complete cycle of sunspot activities) have also confirmed the expected variation in the electrical conductivity of the layers. The recent reports of reception in America of television signals from the Alexandra Palace were not at all mystifying; they were a consequence of the present high conductivity of the reflecting layers in the upper atmosphere.

Professor W. L. Bragg gave a lecture on X-ray Optics, developing the subject from a consideration of the spectra produced by diffraction gratings with periodic irregular spacing, two crossed gratings, and proceeding to explain how a crystal acts as a complicated grating for X-rays.

Lectures were also given by Professor O. T. Jones, Dr H. B. Cott and Mr N. E. Odell, and demonstrations of photochemical processes by Professor Norrish.

Nutrition and Health

By C. H. MARCH

IV. Protective and Non-Protective Foods

(This is the fourth article in Mr C. H. March's series "Nutrition and Health". His last article, which appeared in the November issue of Discovery, *dealt with Minerals and Vitamins. This month he tells us which foodstuffs supply those minerals and vitamins, and which supply energy.)*

THE LEAGUE OF NATIONS has divided foods into two big groups, known as the Protective Foods and the Non-Protective Foods. The first group, in addition to supplying energy, supplies one or more of the valuable minerals and vitamins and first-class protein. Included in this group are milk, cheese, butter, eggs, fresh meat and fish, wholemeal bread, fresh and cooked vegetables (providing they are cooked without soda), and fresh fruit and some tinned fruits.

The non-protective foods are those which supply mainly energy. Included in this group are sugar, sweets, biscuits, cakes, white bread, jellies, etc. Most of these are very high in energy value which is derived chiefly from carbohydrates.

Foodstuffs and their Constituents

Various foods contain different proportions of vitamins and minerals, and substances providing energy. Breads are the first foodstuff we will consider. Nearly all bread contains 30–40 % of water. The protein varies between 6 and 10 %; there is only about 2 or 3 % of fat, but the carbohydrate content is about 50 %, and it consists almost entirely of starch. A pound of bread contains about 1200 calories. Some breads have milk added to them, in which case they have a higher amount of protein and more calcium and phosphorus. Ordinary white bread has practically no vitamins in it, but wholemeal bread, wheat germ bread or bran bread all contain vitamin B_1, the vitamin that prevents neuritis, certain types of constipation and beri beri.

Most cakes have a much lower protein value than breads, only about 3 or 4 %. Cakes have about 20 % of water. Most cakes have quite a lot of fat, but generally speaking it is not the best type, for usually it is vegetable fat, containing practically no vitamins. Cakes are very high in carbohydrate, 65 % being quite a common figure. They provide about 1600 or 1700 calories a pound.

Biscuits have only a little water (7 or 8 %); they have only about 4 or 5 % of protein. In the sweet biscuits the amount of fat is usually low, 10 % or less, but in the dry or crisp biscuits there may be up to 40 % of fat. Biscuits have a lot of

carbohydrate, and 75 % is not uncommon. A pound of biscuits would give 2000 calories.

Most flours, self-raising, cornflour, arrowroot, ground rice, etc., have over 80 % of carbohydrate, and they provide about 1600 calories per pound. About the same number of calories is contained in a pound of tapioca, vermicelli, sago or spaghetti.

Cereals

These days there are so many breakfast foods that one wonders just which it is best to eat. From an energy point of view there is little to choose. Whether you buy flakes, biscuits, cereals to make porridge or puffed cereals, you are still getting about the same amount of energy, namely 1600 calories for a pound of breakfast food. Oatmeal is probably the most economical winter breakfast food because it has what the others lack, about 10 % of fat, and this gives it an energy value of about 250 calories per pound more. Of course if the flaked cereal is made from the whole grain you are still getting your bit of extra vitamin B, although you would get just as much in oatmeal. If you work it out in money you will see the advantage of the oatmeal; for about 3*d.* you can get a pound of oatmeal which has an energy value of approximately 1850 calories. Therefore for each penny you will be getting 616 calories. A typical flaked cereal, for instance, will cost about 8*d.* a pound, and for that 8*d.* you will get about 1600 calories, so that the flaked cereal will be giving only 200 calories for a penny.

There is very little difference in price between brown rice and white rice; the white is the polished sort, and the rice germ containing vitamin B has been removed; the brown, which is slightly cheaper, is the rice grain with the husk removed, but with the germ intact, so that, in this case, the cheaper food contains an extra amount of vitamin B. It is interesting to note that among eastern races, where rice is the staple diet, the change from the brown rice to the polished has resulted in a tremendous increase in the incidence of beri beri.

Meats

Meats contain no carbohydrate. Liver, however, usually contains a little carbohydrate called "glycogen" or "animal starch". The number of calories in meat depends upon the amount of fat that goes with the meat. Take an average chop for example. If you eat everything except the bone you get about 400 calories; if you eat only the bit of lean in the centre you get only about 200 calories. The protein in meat is first-class or animal protein. Its chief minerals are iron and phosphorus and the chief vitamin is B. Liver is a valuable source of first-class protein, and from it you get more for your penny than from any other food. In addition to first-class protein it contains vitamins A and D. Kidneys are also a cheap source of first-class protein. Tripe is very disappointing as an article of diet, for it contains nearly

90 % of water (about as much water as there is in milk) and has quite a low protein value (9 %). The ordinary cuts of meat have about 60–70 % of water and 13–20 % of protein. The average cut of meat has an energy value of about 1200 calories per pound if both fat and lean are eaten. Veal, however, has little fat and its energy value is lower, about 600–800 calories per pound.

Rabbits are a very good source of first-class protein; they have over 20 % and give 600 calories per pound: poultry gives about 1000 calories for each pound weight.

Fish

Fish is a very valuable food. The idea that it is specially good for the brain is quite incorrect. Fish contains phosphorus and calcium and iodine. The vitamins are mainly A and D, and it is an excellent source of first-class protein. The dried ling fish has as much as 30 % of protein. Most of the dried fish have only 1 or 2 % of fat (kippers are an exception). Fresh fish varies in fat in different seasons, but the mullet has the greatest amount and so has the highest food value. Mackerel have only a small amount of fat and are, therefore, the best sort of fish to fry. The high temperatures used in frying tend to break down the fish oils into rancid products which may give an unpleasant taste and odour to the fish. Crabs, crayfish and prawns have very little fat, but are all good sources of protein. Oysters are rich in iodine and they contain 11 % of protein and 3 % of fat. Even so scallops have a higher food value; they have 16 % of protein and 3 % of fat. Mussels are inferior; they have only 7 % of protein and 2 % of fat.

Dairy Products

Dairy products constitute one of the most valuable groups of foodstuffs. Included in this group are milk, butter, cheese, cream and eggs.

Milk is one of the best natural foods we possess. It contains about 3 % of protein, about 4 % of fat and 5 % of easily digestible carbohydrate in the form of milk, sugar or lactose. Its protein is first-class. It contains, in addition, the vitamins A and D, besides the minerals phosphorus and calcium. The League of Nations recommends the consumption of $1\frac{1}{2}$ pints of milk per day by growing children, and 1 pint a day at least for adults, 2 pints a day for expectant mothers. It is very difficult indeed to balance a civilized diet without the daily supplement of milk.

Many people are scornful of the value of skim milk as a food, yet all it has lost is its 4 % of fat and its vitamins A and D. It still contains its first-class protein, its valuable minerals and its carbohydrates but, although it is so valuable, there is a great waste of skim milk throughout the world. It is an article of diet which should not be despised.

Ice-cream is a valuable food. With 4 % of protein, 10 or 11 % of fat and 14 % of sugar, it has a food value of 800 calories per pound. If a child has a sweet tooth it is far better to let him have ice-cream than sweets.

Cheese is one of the best sources of food we have. It is made up of about 25 % of first-class protein, and 30–40 % of fat containing vitamins A and D. It contains the same minerals as milk, and is an extremely valuable food in every way.

Vegetables and Fruit

Vegetables and fruit have only a small energy value, but they are valuable dietary correctives. They have an alkaline ash which serves to counteract the acid ash of meat, eggs, cereals, cakes, etc. They are the only source of the vitamin C in the diet. Potatoes, oranges, lemons, strawberries, pineapples, tomatoes and fresh green vegetables are the best from this point of view.

Green vegetables, even when cooked, supply vitamins B and C, but only if they are cooked without soda. The yellow vegetables and fruits supply carotene, the precursor of vitamin A. Many vegetables, particularly the green ones, are excellent sources of iron.

Most soups or broths are only flavoured water and contain practically no nourishment. A patient would starve to death if no other food were given besides chicken broth, which so often is regarded as the best nourishment for invalids. Various meat extracts contain no protein and also are practically valueless from a food point of view, although they do provide the body with some mineral salts. But one would starve to death in a very short time on a meat extract as the only source of food. The yeast extract Marmite is regarded the world over as the best source of vitamin B available.

The Food of the Little Owl

Derived from pellets, February 1936 to January 1937

RESULTS OF A YEAR'S OBSERVATIONS OF A SINGLE BIRD, ITS MATE AND FAMILY (SOUTH DOWNS, SEAFORD)

By J. F. THOMAS

At the very beginning of the inquiry into the food of the little owl, organized by the British Trust for Ornithology, the writer was fortunate enough to come across one bird which remained in the same area throughout the year. This area was visited every 3 or 4 days from 3 February 1936 to 31 January 1937, with the exception of the periods 2 April–9 May, 1 August–20 September and 16 December–19 January, and every visit produced at least one pellet, save only for a fortnight at the beginning of December. During the summer months a second bird was in evidence, and they doubtless had a nest and young, though nothing was seen of the latter. It should be mentioned, however, that among the numerous little owl feathers picked up from July to October there were six which Miss Hibbert-Ware identified as

juvenile. Many of these feathers were found at the entrance of one particular rabbit-hole, and twelve pellets came from the same place during 5 weeks in June and July.

The actual area worked was about 200 yd. long by 100 yd. wide, and formed part of the steep western side of a valley running north and south, situated 2 miles north of Seaford and 300 ft. above sea-level. This side of the valley consisted of scrubland with a few small trees scattered about, and three clumps of bushes or trees, blackthorn, may, and elder. The whole of the area, together with the eastern side of the valley which was grassland, formed part of 300–400 acres, in which about thirty heifers roamed at will. There were many rabbits.

Skylark, meadow pipit, corn bunting, stonechat, whitethroat, linnet, blackbird, song thrush and of game birds the common and red-legged partridge, have all been known recently to nest in or very close to the area.

(*Mallinson*)

Young Little Owls

Method of Observation

Observation started on 3 February 1936, when a bird was first seen; thereafter frequent visits were paid, and gradually an idea of the favourite ejecting sites was obtained; these were closely examined at each visit, and other possible places searched. All pellets collected from the same site on any day were placed in a separate paper bag and forwarded to Miss A. Hibbert-Ware, to whom the writer is indebted for all identifications and for much valuable advice.

Occasionally a new site would be found, or perhaps an old site that for some reason the bird had deserted for a long time and which consequently the writer had neglected to visit; in the cache then examined there might be pellets aged 2 or 3 months or more; hence the anomaly of a February pellet containing cockchafer, or of finding *Tipula* eggs at the end of November.

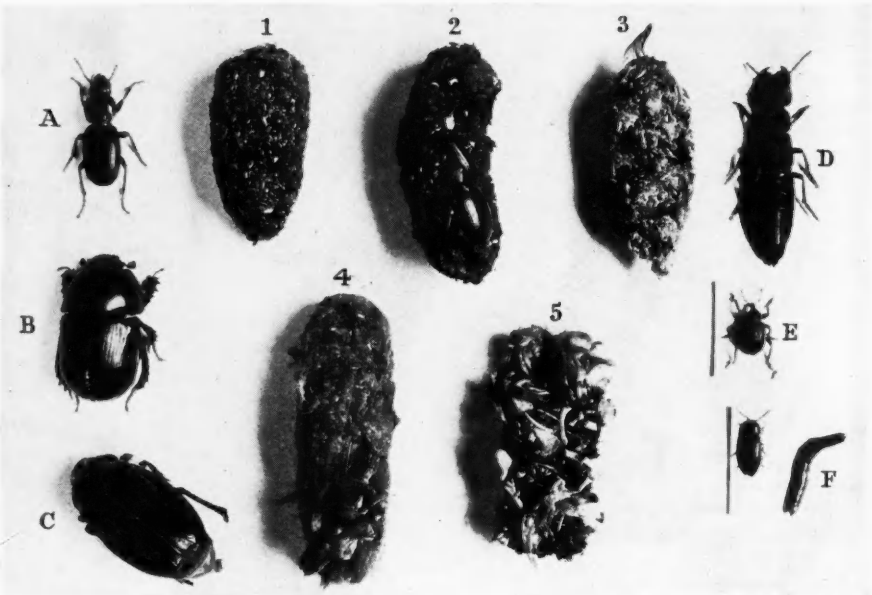
During the summer the pair was watched for long periods, both in the afternoon and the evening; during daylight hours they were decidedly lethargic and seldom flew far unless forced; on two occasions only, a bird was seen to pick up something small from the ground. After sunset, however, they became more and more active, until shortly before it was too dark to watch them they were continually on the move.

Number of pellets

The total number of pellets examined from the area was 368, and they were distributed among the months as follows:

February	36	September	55
March	53	October	35
May	38	November	50
June	37	January	26
July	38		

It is probable that a fair number of the September pellets belonged to August, and



(*W. Tams*)

1—5. *TYPES OF LITTLE OWL PELLETS*

1. *Earwig pellet.*
2. *Beetle pellet.*
3. *Bird and Beetle pellet.*
4. *Rodent pellet.*
5. *Weathered Rodent pellet.*

A—F. BEETLES THAT DOMINATE THE PELLETS

A. Ground Beetle.
B. Dor Beetle.
C. Cockchafer.
D. Rove Beetle.
E. Weevil.
F. Click Beetle and its wireworm larvae.

occasionally a few of those for other months refer to an earlier period, but on the whole they were well distributed throughout the year, and seem a very fair sample of the food of this particular bird and its family.

The sizes of the pellets were normally from 1 to 1½ in. long, or occasionally 2 in., and the usual weight was about 1·2 g. In all but a few instances, and even when the pellet contained mouse or vole, the shiny parts of beetles were clearly visible on the outside.

In the following table the pellet contents are shown month by month. In order to make a fair comparison and to show the sequences better, it has been thought advisable to reduce the three months with fifty to fifty-five pellets to the equivalent of thirty-seven pellets and to bring up January's twenty-six to the same number, but the totals in the right-hand column are the actual numbers of insects, etc., obtained during the year.

In addition to some remarks on the different items in the table, a few notes are given about other creatures found in the pellets.

(1) Six small Passerine birds were detected in the pellets—two of these were

Pellets	1936 Feb. 36	Mar. 53*	May 38	June 37	July 38	Sept. 55*	Oct. 35	Nov. 50*	1937 Jan. 26†	Total (actual) 368
(1) Birds	1	1	1	1	1	—	—	—	—	6
(2) Rats	—	—	2	—	—	—	—	2	—	5
Voles	1	1	4	—	1	1	3	—	—	12
L.T.F.M.	2	1	3	2	10	1	6	4	4	35
Shrew	2	—	2	—	—	1	1	1	—	8
(3) *Carabus*	16	15	36	15	8	1	—	—	1	98
Pterostichus	7	4	64	77	122	44	20	27	—	397
Other Carabids	33	25	127	144	140	52	137	93	16	830
(4) *Staphylinus olens*	1	4	10	7	9	69	63	36	16	260
Other Staphylinidae	28	36	53	9	28	91	175	113	179	763
(5) *Necrophorus*	—	—	4	2	1	2	6	—	—	17
(6) *G. typhaeus*	7	4	—	1	—	—	—	2	4	20
Geotrupes sp.	11	15	23	18	4	32	34	29	1	200
Aphodius fossor	10	54	91	61	33	9	—	1	—	287
								prodromus		
Melolonthids	1	—	—	—	120	10	—	7	—	145
(7) Wireworm and click beetles	—	4	18	69	3	—	—	3	—	100
(8) *Meloe*	—	—	8	—	—	—	—	—	—	8
(9) Weevils	2	22	15	7	2	2	7	2	4	73
(10) *Forficula*	358	129	289	86	4	53	2232	1360	238	5232
(11) *Tipula* eggs and insects	—	—	—	—	—	Very numerous	—	A few	—	

* Reduced to 37.

† Brought up to 37.

probably chaffinch; in addition, a song thrush was found decapitated and with its breast eaten—though this was not under any of the little owl's favourite perching places, it should be added to the six birds above. No other bird's carcase was found, though at every visit a search for pellets was being made at all likely places.

(2) Where, as occasionally happened, rodents have been identified as "mouse or vole" owing to the fact that no jawbones were found, they are entered in the table as long-tailed fieldmouse and vole alternately.

(3) Carabidae. These "hunting" beetles were numerically the most important among the beetle families found in the pellets, and of them *Pterostichus madidus* occurred most frequently, reaching its peak in July.

(4) Staphylinidae. The devil's coach-horse (*Ocypus olens*) figures largely during September and October, and also probably August; this is not at all surprising, as the creature was to be seen running about everywhere. The other Staphylinidae were mostly *S. aeneocephalus* and *S. morio*.

(5) *Necrophorus*. The six burying beetles in October appeared in pellets shortly after

a rabbit-catcher had gutted 30 to 40 rabbits and left the entrails on the ground in the middle of the area.

(6) Scarabeidae. While *Geotrupes* sp. (probably mainly *G. stercorarius* and *G. spiniger*) were taken fairly constantly throughout the year, *G. typhaeus* (the trident bearer) made its appearance on 12 November, continued through the early months of the year, and finally disappeared (for 7 months) after 25 March, with the exception of one in June. The type of country, with its numerous rabbits and dry soil, is just right for this insect. *Aphodius fossor* started in the late winter, reached its peak in May (a batch of three pellets on 13 May produced forty-five), and finally disappeared in July.

The first cockchafer (*Melolontha vulgaris*) appeared in a pellet on 6 July, and there were well over 120 during the rest of the month. Fifteen of a smaller species occurred on 27 September, and ten more on 15 November.

(7) Elateridae. Fifty-six click beetles appeared in four pellets on 17 June.

(8) *Meloe*. Eight violet oil beetles occurred in May.

(9) Curculionidae. *Phytonomus* and other weevils suddenly became numerous in March.

A few examples of other species of beetles, both rare and common, occurred, of which we may mention five tiger beetles (*Cicindela campestris*) in the spring and early summer. And a single example of the rare weevil, *Procas armillatus*, was identified by Dr Blair in February.

(10) *Forficula*. The number of earwigs in a pellet is ascertained by counting the pincers and dividing by 2. The numbers eaten by this little owl were enormous—well over 2000 in October and nearly 2000 in November; the average per day throughout the whole year works out at about $14\frac{1}{2}$, and the greatest number in one pellet was 343! Other single pellets contained 255, 243 and 181 insects respectively. And yet the writer really thinks that they are understated, and for this reason: an insect pellet often breaks up on falling to the ground, and amongst the debris thus scattered about one can see and pick up a beetle's head, legs and elytra, but the earwig pincers under these conditions are practically invisible, and very many must have been left behind.

In some years earwigs at Seaford become a veritable plague in September and October, entering houses even to the second floor and being found in clothes, towels, sponges, etc., but they were not specially noticeable in this way in 1936.

(11) *Tipula*. Daddy-long-legs begin to be seen on the Downs about the beginning of May, but neither the imagines nor the eggs were in evidence in pellets until 23 September, when observations were restarted after a break of two months. From that date for about a week the eggs, and sometimes the perfect insects, were found in most pellets, the former generally in very considerable numbers.

Other contents

Dung forms the matrix in a large number of pellets.

Setae of worms occurred fairly often, most frequently in November.

One grass snake and a slow-worm, together with two lizards and a frog, occurred.

Lepidoptera. About ten larvae were detected in March, and three or four more in other months.

On 17 June a pellet was found containing a great number of eggs of a large moth (poplar hawk) with remains of the moth itself.

Hymenoptera. On 2 November a fresh pellet was picked up containing the heads of some hymenopterous insect.

Diptera. One dipterous fly on 19 July.

Millipedes and woodlice. Millipedes were identified in seven of the summer pellets, and woodlice once in July and a second time in October.

It may be of interest to name the contents of a few pellets.

17 May. 2 pellets (new since 14th)

1 *Meloe proscarabaeus*
4 *Pterostichus madidus*
8 *Geotrupes* sp.
1 *Aphodius prodromus*
1 *Carabus nemoralis*
1 *Staphylinus olens*
1 *Staphylinus* sp.
2 weevils
23 *Forficula*
2 larvae
1 lizard
1 vole

12 July. 1 pellet and fragment

23 cockchafers
1 *Necrophorus* (black, yellow and orange)
Setae of worms
Woodlouse plates

4 October. 3 pellets

26 *Staphylinus olens*
3 *Geotrupes* sp.
20 *Nebria brevicollis*
3 other Carabids
204 *Forficula*
1 long-tailed fieldmouse

Coleoptera found in pellets during the investigation

CICINDELIDAE
Cicindela campestris L.

CARABIDAE
Carabus violaceus L.; *C. nemoralis* Müll.; *Leistus spinibarbis* F.; *Nebria brevicollis* F.; *Harpalus aeneus* F.; *Pterostichus madidus* F.; *P. vulgaris* L.; *Abax ater* Vill.; *Cyrtonotus apricaria* Payk.; *Amara* sp.; *Calathus fuscipes* Goeze.

STAPHYLINIDAE
Staphylinus olens Müll.; *S. globulifer* Fourc.; *S. aeneocephalus* De G.; *Philonthus fuscipennis* Mann.; *Creophilus maxillosus* L.; other Staphylinids.

SILPHIDAE
Necrophorus humator Goez.; *Thanatophilus rugosus* L.; *Phosphuga atrata* L.

HISTERIDAE
Hister neglectus Germ.

BYRRHIDAE
Byrrhus pilula L.

LUCANIDAE
Sinodendron cylindricum L.

SCARABEIDAE
Onthophagus vacca L.; *Aphodius fossor* L.; *A. prodromus* Brahm; *Geotrupes typhaeus* L.; *G. stercorarius* L.; *G. spiniger* Marsh.; *Geotrupes* sp.; *Amphimallus solstitialis* L.; *Melolontha vulgaris* F.; other Melolonthids.

ELATERIDAE
Agriotes lineatus L.; *Lacon murinus* L.

TELEPHORIDAE
Larvae of *Telephorus*.

CHRYSOMELIDAE
Chrysomela polita L.; *Timarcha coriaria* Laich.

TENEBRIONIDAE
Blaps mucronata Latr.

MELOIDAE
Meloe proscarabaeus L.

CURCULIONIDAE
Otiorrhynchus clavipes Bonsd.; *Cleonus piger* Sc. (local); *Procas armillatus* F. (rare); *Sitona* sp.; *Phytonomus punctatus* F.; *Barynotus obscurus* F.

From *Catalogue of the Coleoptera of the British Isles*, by Sir T. H. Beare, 1930.

At the Turn of the Tide

SYDNEY SMITH, reviewing Waterton's *Wanderings in South America*, wrote that the author appeared in early life to have been seized with an unconquerable aversion to Piccadilly, and to be happy only when he had left his species far away and was at last in the midst of his baboons. Similarly Mr Perry is most happy when he is among "the birds that dwell in almost the last wild places of English country; fresh-marsh and salting, mud-flat, sand-bank and sea-girt island...the saltings of Solway...the tidal slakes and islands off grey Northumbria".

Mr Perry's wanderings by day and night amid such scenes have given him exceptional opportunities for observing both common birds and rarer ones which to more stay-at-home naturalists are only known from all too-infrequent visits to their haunts. He is both a careful observer and an original thinker; his theories are all founded upon actual observation in the field, and therefore deserve respect even if they are not always convincing.

Every field-naturalist has at some time or other been fascinated by the sight of the aerial evolutions of large flocks of birds. In his book* Mr Perry has a chapter on "Simultaneous Flight-movement". He postulates both a sixth sense, "a form of telepathy" (physical as much as mental), and "a sensitive visual alertness of one bird to the actions of another" interpreted with a celerity beyond our emulation and perhaps conception, so that the manœuvre appears simultaneous to our eyes.

"To a bird, perhaps a second, as I know it, may represent sixty well-marked divisions of time, so that...one individual's change in direction must always precede another's by some margin of time....In these united evolutions on the wing, a bird turns, and the movement is *anticipated* by those birds nearest him."

The rest of the flock "*sense*, rather than follow, the direction of the turn" though to us the movement seems "one coincident action", which indeed it is according to our measurement of time.

These questions have received attention from many scientific observers, especially from E. Selous in *Thought Transference or What?*, and Coward in *Bird Life at Home and Abroad*, and other works. Most observers agree that these evolutions do suggest the presence of a special sense in birds whose exact nature we can only surmise, and every field-naturalist must often have been struck by the extreme sensitiveness of birds to the presence of their own kind. Mr Perry rejects the theory of a "leader" in flight formation. Certainly, with golden plover, the foremost bird constantly changes, perhaps, as he suggests, owing to easier conditions to the leeward of a companion. Also the flock sometimes divides, and a small group or

* *At the Turn of the Tide*, by Richard Perry. Lindsay Drummond. 12*s.* 6*d.*

One of the photographs from "At the Turn of the Tide". Northern Guillemots and Kittiwakes on nesting ledges, Noss, Shetland

single bird is left behind. There is more individuality in birds than is generally recognized.

In a footnote on pp. 73–4 Mr Perry suggests that the display of male and female has no bearing on their pairing; he is, he says, beginning to think that the most perfect patterns of display are common only to mated pairs, and serve to excite the "nidificatory or egg-laying machinery" of the female. This is a revolutionary theory, and when Mr Perry returns to the subject in some future work, it will be interesting to see what evidence he can bring forward to substantiate it. He must be aware that there is at present a mass of evidence against it; in fact this book contains a good deal. As, from the same note, he seems to realize, there is no hard and fast division between pre-coition courtship and the display which stimulates nest-building and egg-laying; they are both parts of the same "pattern", a "Five Act Play", as he calls it in another place. Mr and Mrs Marples's exhaustive studies of the breeding habits of terns, and to a lesser extent Mr Kirkman's observations of nesting black-headed gulls, support this theory. Later on in this book he states his belief that all bird emotions are inter-related, and develops the theme in an appendix.

The "broken-wing" trope he rightly sets down as instinctive and not intelligent. (To call it "rational" is inaccurate, for the term connotes tertiary behaviour.) In some species probably it does arise, as he believes, from a mixture of emotions, partly parental regard for the young and partly fear; but in the case of the ringed plover, where this behaviour reaches its most intense form, it is surely parental solicitude that is strongest.

His record of a female roseate tern mating with a male common tern, one would be inclined to doubt, for he did not see either courtship or coition, but only the female roseate sharing incubation of her eggs with the male common tern. Fortunately the downs of the two species are readily distinguishable and he found that the down of the young when hatched was clearly of the common tern type.

On the vexed question of the origin of migration, Mr Perry inclines to a form of the Arctic dispersal theory. He believes that in some past age there was a huge resident avian population on the Arctic tundras; the successive ice ages gradually forced these birds south in winter, to return in the summer as far north as possible. This habit became ingrained and is now instinctive rather than climatic. In this connection he stresses the stimulus to reproduction of almost perpetual daylight during the Arctic summer. The important influence which daylight has upon migration has only recently been appreciated. Professor Rowan's experiments show (to quote Dr A. Landsborough Thomson) that "there is in fact a connexion between the state of the gonads and migratory behaviour and also that the gonads themselves are affected by...the seasonal decrease or increase in the length of daylight".

This is a most stimulating book. Almost every chapter propounds some theory which provokes thought and prompts the reader to test its soundness by his own observations in the field. This is all to the good.

In his Introduction Mr Perry expresses the fear that some may think him "over-colourful". His style certainly incites some such criticism. In search of verbal originality he is prone to become bizarre. No one has written on birds more vividly than Hudson, but his style was simple: someone said of him that he wrote as the grass grows. Let Mr Perry take heed.

The reproductions of paintings by Mr Peter Scott, and others, have great beauty, and there are some fine photographs. E. W. HENDY

SHORTER REVIEWS

Field Determination of Rocks

In 1937 Mr Davison brought out a very useful little book on *Field Tests for Minerals*, as he was well qualified to do from his long experience as teacher of mineralogy and geology at the School of Mining at Camborne in Cornwall. He has now followed this up by a book* on the closely cognate subject of the determination of rocks by simple methods, not needing any elaborate apparatus and mostly capable of application out of doors. The book contains 18 plates and 4 text-figures; the first part consists of concise descriptions of the composition and characteristics of the minerals commonly met with in rocks of all the principal classes, igneous, sedimentary and metamorphic, with a brief note on the usual manner of occurrence of each mineral. This is followed by a short chapter on igneous rocks in the field and this by a somewhat longer one on the origin and classification of igneous rocks. This is, in effect, an excellent condensed textbook of igneous petrology. The two final chapters deal on the same lines with sediments and metamorphic rocks.

A very minor blemish, however, is the rather casual and inconsistent use of capital letters in parts of the book. According to the best modern practice names of minerals and rocks in the middle of a sentence should not be printed with initial capitals, while the names of geological (stratigraphical) units should be capitalized; thus mica and granite, but Cambridge Greensand and Oxford Clay. This is a point perhaps appealing more to an editorially minded critic than to ordinary readers and especially to elementary students to whom the book can be strongly recommended as an introduction to petrography. R. H. R.

* *Field Determination of Rocks*, by E. H. Davison. Chapman and Hall. 7*s*. 6*d*.

The Native Races of Africa and Madagascar

Sir James Frazer describes this book,† of which the present volume dealing with Africa is the first instalment, as an Anthology of Social Anthropology, and we learn that it is hoped it will be followed by similar volumes on Australia, Oceania and Indonesia, Asia, and America and Europe.

The task of arranging the valuable notes made by Sir James has been ably undertaken by Mr Downie, and we can appreciate, even if we had not appreciated long ago, the care and precision with which Sir James has worked, his amazing industry and the avidity with which he has seized on every possible scrap of knowledge which could throw some light on the social organization of people about whom very little was known.

That some of the accounts published in this work are now known to be incomplete or to be biased slightly by the observer, who usually had had no scientific training, does not necessarily detract from the value

† *The Native Races of Africa and Madagascar*. A Copious Selection of Passages for the Study of Social Anthropology from the Manuscript Notebooks of Sir James G. Frazer, arranged and edited by R. A. Downie. London: Percy Lund, Humphries and Co. 35*s*.

of these observations; they were written in good faith at the time. The book contains statements which must be checked, but in checking it is not impossible that it will be found that customs have changed, or that a chance word gives the clue to a custom or belief which may have escaped the notice of even the most efficient investigator armed with all the most modern methods and technique.

But apart from this, it would have been a slur on the reputation of our modern civilization if the works of the writers quoted had been allowed to be forgotten, their work and Frazer's work are of historical interest to all serious students of Anthropology, and we owe our grateful thanks to Sir James for allowing the contents of his notebooks to be made available for our use.

E. B. HADDON

British Birds

To say that this volume* maintains the standard set by its predecessor is to give it the highest possible praise. In completeness and compactness and in arrangement and proportion the design of the series is above criticism; the only reasonable ground for complaint was that the sections which dealt with behaviour were relatively and very notably incomplete; and this was largely due to the general neglect of the subject. As regards the data for the identification of our birds, the descriptions and pictures of plumage changes, the accounts of eggs and nests, of habitat and distribution, the work was wholly satisfactory. It put every other manual out of date and became the indispensable possession of every student of the British air fauna.

The second volume follows the same system as the first, but covers a more interesting field. It includes the family in which identification is most difficult, and to which the largest number of recent additions to the British list has been made—the Warblers; also the bird which more than any other challenges the attention of the student of the evolution of behaviour—the Cuckoo. Sceptical as some of us are as to the meticulous multiplying of sub-species, this account of the Warblers is a clear and thorough piece of work; and the information here available ought to help to a fuller knowledge of the extent and frequency of their visits. These pages are typical of the best feature of the book, its lucid accounts of the differences between species and between sexual and seasonal phases of plumage. Those of us whose education as ornithologists involved years of labour in giving correct names to the more difficult specimens and who could only reach certainty by poring over long series of skins in museums, will be conscious of how much we have lost by being born too early. The younger generation will start with the problems of classification solved for them.

The treatment of the Cuckoo illustrates what is still the weakest element in the work. The account of the Cuckoo's breeding habits—perhaps the most interesting of all ornithological subjects from the standpoint of biological and psychological study—is definitely disappointing, both in what is stated and what is omitted. It is proper that full credit should be given to Mr Chance for his discoveries as to oviposition: but this is a relatively unimportant issue. To the scientist, the question as to whether the hen Cuckoo lays directly into the foster-parent's nest or on occasion inserts her egg in her beak is of small moment. The subject of vital importance is the ejection of the eggs or chicks by the young Cuckoo; and here the information is both incomplete and inexact. There is no mention of the following points: that the young Cuckoo at birth weighs only 4 g. and both then and for 36 hr. later is incapable of ejecting the other occupants; that its very short incubation period, 11½ to 12½ days, gives it normally 2 days before the foster-parent's brood is hatched, during which time it gets all the food brought to the nest; that without this start and unless its egg is

* *The Handbook of British Birds*, Vol. II, by H. F. Witherby, F. C. R. Jourdain, N. F. Ticehurst and B. W. Tucker. Witherby. 25*s*.

laid in the nest of very small birds, it cannot get food enough and usually dies; that in 36 hr. (at the age at which Mr Lancum's photographs were evidently taken) it has doubled its birth weight and is ready for the spasm of gymnastic energy with which it responds to any weight falling upon its back; that its own hungry flounderings at the bottom of the nest, and not any deliberate intention, cause the eggs or newly hatched chicks to roll from the side of the nest on to its back; and that then the actions are regularly co-ordinated and almost uncannily effective. These are all matters which have been fully observed and reported—and their importance to the student of evolution or the ornithologist who cares for more than the dry bones, or empty eggshells, of his subject are obvious. They ought not to have been omitted or stated vaguely.

Similar criticism is invited by several of the accounts of behaviour. It is good to see that the authors repudiate the claim that the drumming of the Woodpecker is vocal; and that they vindicate the reputation of the Little Owl: but there are too many points on which published details are available and would modify statements here made. We know too little of bird habits for any reliable material to be ignored, even if in view of the thoroughness of the book in all other respects such comment seems ungenerous. It is here made in the hope that the remaining volumes of this indispensable Handbook will be improved in this respect. It is the only point, the present reviewer would maintain, in which improvement is possible.

CHARLES E. RAVEN

Modern Criminal Investigation

THIS book* must be considered first as a text-book for police students: and one must congratulate them at once on having such a fascinating text-book, and on being spared the trouble of looking up things in several obscure books (often in foreign languages) as they would have had to do before this work appeared. But it will also become a sort of detective writers' handbook, and it is in that connexion that its contents will mainly be of interest to the general public. It will tempt all writers of this class to become Austin Freemans. Unfortunately for them, however, the book is likely to attract a large following from the readers of detective stories, who will then tend to get one move ahead of their Freeman, as it were; for a great many mysteries of scientific investigation which used to be produced in semi-magical fashion by the Holmeses and Thorndikes are here set forth unemotionally as being ordinary parts of police routine (though one notes with interest that the Holmesian confidence in tracing tobacco ash is not shared by Messrs Södermann and O'Connell).

Those detective story addicts who read this book must not be put off by the excessive naïveté of much of the writing, which is particularly evident in the early chapters. They must assume that several thousand American policemen with simple minds and great hearts are studying the book, and that they have to be lured on by having it put very plainly, although the policemen will ultimately find themselves jerked into some quite heavy scientific studies. Undoubtedly the book covers its ground well: the finger-print and ballistic sections are particularly clear and well informed. The writers refrain from committing themselves too much on the thorny question of "time of death"—although they disclose one or two factors which I had fondly hoped were a secret between my doctor and myself. With so much provided, it is perhaps uncivil to demand more. But I should have welcomed some information on the relations of police with banks and lawyers. It would have been useful to disabuse some of our writers of the illusion that bank managers are prepared on the least encouragement to discuss the financial affairs of their clients. And possibly a chapter could have been

* *Modern Criminal Investigation.* By Harry Södermann and John J. O'Connell. Bell. 12*s.* 6*d.*

added on problems of transport as they affect apprehension of criminals.

To me the most striking and suggestive part of the book was that on the reliability of witnesses. I had never quite realized —and I am sure my fellow detective-writers had not realized either—the number of ways in which perfectly honest witnesses are often quite unreliable. (I ought to mention that Agatha Christie has scored a clever point here in *Appointment with Death*.) Most writers divide their witnesses into two classes: good witnesses who tell the truth, bad witnesses who tell lies. It does not take much thought to see how naïve that is; but it would take a good deal of thought to invent some of the ways by which, in actual fact, well-intentioned witnesses have managed to mislead themselves.

It is a pity that Messrs Södermann and O'Connell cannot be installed somewhere as critics of detective story writers. I hope at least that the critics will have this book by them in future. R. PHILMORE

Men Against Death

THE colloquial American style, so pleasing when presented by Damon Runyon, is rather unsuited to biography, especially scientific biography, and it is with some disappointment that one meets, in a book containing such excellent and interesting matter, phrases like: "What Carpenter got for his pains was the horselaugh from Ithaca doctors (excepting one)."

Dr de Kruif, who has gained a considerable reputation from his popular accounts of scientific research, presents, in this book,* a series of episodes in the history of disease prevention. He has selected his material carefully, and gives a fairly complete account of the work done on nine of the better known diseases. Much of this will already be familiar to a number of readers, such as Banting's work on diabetes, and that of Semmelweis on puerperal fever.

* *Men Against Death*, by Paul de Kruif. Scientific Book Club. 3*s*. 6*d*.

The section on the aetiology and cure of syphilis is particularly thorough and valuable, as it contains a good elementary account of the various serum reactions, culminating, of course, in the discovery of the Wassermann reaction. The case for compulsory pasteurization of milk is also stated most convincingly.

The Scientific Book Club is to be congratulated on the publication of this book at a cheap rate for its members, but it seems unfortunate that an English edition was not specially prepared. R. M.

Select List of Books Received by *Discovery*

(*Mention in this list does not preclude review*)

The Social Function of Science. J. D. BERNAL. (Routledge, 12*s*. 6*d*.)

Poison Arrows. GRACE THOMPSON SETON. (Travel Book Club, 3*s*. 6*d*.)

The Health of the Nation and Deficiency Diseases. JOHN MABERLY. (Baillière, Tindall and Cox, 5*s*.)

Content of Mind. S. HARRISON. (Pitman, 3*s*. 6*d*.)

Food and Health Vitamins. R. H. A. PLIMMER and VIOLET G. PLIMMER. (Longmans, 5*s*.)

The Elements of Radio-Communication. O. F. BROWN and E. L. GARDINER. (Oxford University Press, 16*s*.)

General Anthropology. Edited by FRANZ BOAS. (Heath, 15*s*.)

Science in Africa. E. B. WORTHINGTON. (Oxford University Press, 10*s*. 6*d*.)

African Odyssey. JOSEPH CRADD. (Travel Book Club, 3*s*. 6*d*.)

Revision Notes in Inorganic Chemistry. E. P. WILSON and F. W. AMBLER. (Heinemann, 4*s*.)

The World of Engineering. J. L. DIXON. (Scientific Book Club, 2*s*. 6*d*.)

A Short History of the Steam Engine. H. W. DICKINSON. (Cambridge University Press, 15*s*.)

cure of
nd valu-
mentary
actions,
overy of
ase for
is also

be con-
is book
it seems
was not
R. M.

eived

ot

J. D.

SETON.

fficiency
Baillière,

Pitman,

H. A.
LIMMER.

nication.
RDINER.

FRANZ

NGTON.
d.)
(Travel

emistry.
AMBLER.

DIXON.

Engine.
ge Uni-